The Mining Magazine

PUBLISHED AT SALISBURY HOUSE, LONDON.

INDEX TO VOLUME XVII.

FROM JULY TO DECEMBER, 1917.

EXPLANATORY NOTE.—Items in italics are names of books reviewed; illustrated articles are denoted by Asterisks (*); the letters (*m.d.*) refer to notices of articles under the heading 'Mining Digest.'

The Mining Magazine

FOUNDED IN 1909 BY T. A. RICKARD AND EDGAR RICKARD.

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.Sc., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill,* both Editions.

BRANCH OFFICES { 420, Market Street, San Francisco. 2,124, Equitable Building, New York.

SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XVII. LONDON, JULY, 1917. No. 1.

CONTENTS.

EDITORIAL

COPIES of Dr. E. T. Mellor's geological map of the Rand have arrived in this country. His interpretation of the stratigraphy of the region is based on the study of years, and will be accepted with little or no criticism. The map undoubtedly will become a classic.

INTERRUPTIONS in the ocean mail service make it difficult for us to give a reasonably prompt and complete review of the world's literature relating to mining and metallurgy. We mention this matter because our Mining Digest this month occupies fewer pages than usual. The War is also responsible for considerable delay in the publication of statistics of trade and metal production.

THE Court of Appeal has confirmed Mr. Justice Eve's judgment against the Amalgamated Properties of Rhodesia in the action with the Globe & Phœnix. The arguments centred on the legal interpretation of the contracts as they were affected by the law of extra-lateral rights, and were of no interest to the mining engineer or geologist. Notice has already been given that the case will be taken to the House of Lords.

ENDOWMENT of research on a large scale is the form that the memorial to the late Sir William Ramsay is to take. A hundred thousand pounds is the amount mentioned. The interest on this sum will be devoted to the establishment of fellowships, which will be granted to mature investigators rather than to budding students. Ramsay was the most energetic and daring chemist that this country has produced, and he deserves a substantial and generous monument in his remembrance.

CIVIL engineers have a proverbial prejudice against mining engineers, and they usually endeavour to belittle the services of mining men. The Canadian Mining Institute is the latest victim of this unjustifiable jealousy. A memorandum issued by the authority of the Canadian Society of Civil Engineers was recently presented to the Canadian Government in connection with the national movement for industrial preparedness. This memorial contained the absurd statement that of the 1,017 members of the Institute, 200 were qualified technical men and 817 were lay members. Furthermore it was alleged that the Institute was "to a great extent a trade organization." Protests were naturally made, but the only reparation so far forthcoming from the Society consists of a formal reference of the memorandum back to the individuals who wrote it.

WEST AUSTRALIA has in the new Minister of Mines, Mr. R. T. Robinson, a public servant who is putting his whole heart into his business. Our Kalgoorlie correspondent tells of the Mining Conference recently held, having for its objects the closer collaboration of the various associations of owners and men, and the consideration of proposals for encouraging prospecting. The conference was an undoubted success. The beneficent attitude of the Government can do much, after the war, to provide occupation for ex-soldiers, and to assist the development of the mineral and other resources of the State. The new agent-general in London, Mr. J. D. Connolly, is keenly interested in suggestions for the improvement of West Australian mining conditions.

DR. ADDISON, the Minister of Munitions, delivered a notable address in the House of Commons on June 28, dealing with the enormous expansion of the department under his control. We have no space for any lengthy quotation, but two of his statements demand mention. In the first place he announced that a process had been adopted which would provide all the potash required in this country. Second, he gave credit to Mr. Kenneth Quinan for the design and rapid construction of the new Government explosive factories. Mr. Quinan is the manager of the Cape Explosive Works, and is the cousin of the late Mr. W. R. Quinan, the American chemist and engineer, who, with Cecil Rhodes, founded the factory at Somerset East near Cape Town. The success of that enterprise has been one of the romances of industrial science, and provided a good augury for the efficiency of the work done for the Ministry of Munitions.

OUR iron ore resources are being studied by the Department of Scientific and Industrial Research. Under the auspices of this department, a report has been prepared by Mr. G. C. Lloyd, secretary of the Iron and Steel Institute, on the deposits in the United Kingdom and the British Empire, with notes on the occurrences in foreign countries. Included in the report are accounts of the ores of metals used in conjunction with iron: chromium, tungsten, manganese, titanium, cobalt, nickel, and molybdenum. The report is a convenient synopsis of the present position, and, being sold at the low price of two shillings, brings the information within the reach of everybody. The report has been made additionally interesting and valuable by the collaboration in its preparation of Professer Henry Louis.

FLOTATION litigation in the United States appears to be getting into a worse tangle than ever. Minerals Separation won its case in the court of first instance last year against the Miami Copper Company in connection with the Callow process. Now comes the news that this judgment has been reversed in the Circuit Court of Appeal by a majority of the court. The view taken was that though the Callow cell was not in itself an infringement of the agitation-froth method, the preliminary agitation by mixing was. The dissenting judge held that the Callow process did not infringe at all. Obviously the case must go to the Supreme Court. Another dispute now in the courts is between Minerals Separation and the Butte & Superior. It will be remembered that, in the case against Mr. J. M. Hyde, whose process is used by the Butte & Superior, the Supreme Court gave judgment for Minerals Separation. The mining company then started to use more than 1% of oil. To these tactics Minerals Separation replied by claiming their right to any process which produced the same result as when less than 1% is used, the argument being that the essence of their invention is the existence of a critical percentage for the amount of oil, and that the addition of more oil has no influence in any way on the efficiency of this principle. So all the arguments have to be sifted by the courts once more.

St. John del Rey.

At the meeting of the St. John del Rey Company, one of the shareholders, a man of influence in mining circles, grumbled at the directors for not distributing a larger dividend. We wonder that anyone so well versed in finance should question the wisdom of the St. John del Rey policy. The money held in reserve is required for the business of the company. There is no object in distributing dividends and afterwards having to raise additional capital. It is cheaper to use your own money than to borrow it from somebody else. This is an old mine, the deepest gold mine in the world. When Mr. George Chalmers took control thirty years ago, after the collapse of the workings, the prospects were none too bright and the finances were involved. By careful labour the mine was put into excellent order, and by the husbanding of funds the debenture debt has been repaid. For the last few years the preference and ordinary shares have received 10% dividend, on a capital consisting of £100,000 in preference shares and £546,265 in ordinary shares. The ore-body shows an unusual persistence in depth. The lowest level, horizon 20, is 5,826 ft. vertically below outcrop, and the opening of the 21st at 6,326 ft. will be commenced shortly. Work at such depths involves large expenditures that are usually classified as capital costs, and sums roughly equal to the dividends and corresponding to one tenth of the yield have been put aside every year out of the income to meet these expenses. The nature of the ore-body, the constitution of the ore, and the methods of development and mining have often been described in our pages. Suffice it now to say that at the lowest level the ore-body is as strong and valuable as at any point above, and that the proved reserve is equal to a five years' supply. The problem of continuing operations at greater depths is being seriously considered. If the ore proves persistent for another two or three levels, representing 600 ft. or 900 ft. in vertical depth, extensive additions will be necessary to hoisting plant, and also to the plant for ventilating and cooling the air. Thus it is obvious that the company will require a liberal supply of funds wherewith to open and operate at greater depths.

It is often forgotten that the company owns large tracts of high-grade iron ore, which, however, under present conditions of transport, cannot be developed. Mr. Chalmers has patiently evolved a plan for smelting these ores by means of charcoal. The region is one that is congenial to vegetation, and it is possible to contemplate the inauguration of a vast timber-growing scheme. Distillation furnaces for the manufacture of charcoal and valuable liquid and gaseous by-products have been erected, and tried experimentally with encouraging results. The company also owns manganese deposits, and in view of the pressing demand for Brazilian manganese ores, particularly in the United States, one of these is being actively developed. But before any vigorous production can be undertaken, the railway communication with the coast will have to be greatly improved. Still another new venture mentioned by Mr. Chalmers is in connection with alluvial gold deposits. These are not rich, but appear to be capable of yielding fair profits if worked on a suitable scale by modern methods. Altogether this grand old company is in as sound a condition as ever it was.

British Decimal Coinage.

Last month we discussed the proposals for the introduction of the metric system of weights and measures. Subsequent inquiry shows that, though most people admit the advantages of the simple system, the inclination to leave things alone preponderates, and that the technical bodies will recommend non-interference. For accuracy of measurements the engineers appear to be in favour of the mil, the thousandth part of an inch. But we doubt not that the metric system will be increasingly used, and that its chance for universal adoption will become brighter as years go on. Since we wrote last month, the question of decimalizing our coinage has come before the public, by the issuance of a report by the committee of the Institute of Bankers. As with the engineers, so with the bankers, there is a strong aversion to a change in unit, and the pound sterling is to be retained. The decimalization would be effected by dividing the pound into 1,000 mils. At the outset we may recommend the invention of some other word, to avoid confusion with the linear unit. The proposed subsidiary coinage is shown in the following table:

Coin	Metal	£	Mils.
Sovereign	Gold	1·000	1,000
Half-sovereign	,,	0·500	500
Double florin (or four shilling piece)	Silver	0·200	200
Florin (or two shilling piece)	,,	0·100	100
Half-florin (or shilling)	,,	0·050	50
Quarter-florin (or sixpence)	,,	0·025	25
Ten mil piece	Nickel	0·010	10
Four mil piece	Bronze	0·004	4
Two mil piece	,,	0·002	2
Mil	,,	0·001	1

It will be seen that the sovereign, half-sovereign, double florin, florin, shilling, and sixpence are retained, and the three-penny piece, half-crown, and crown discontinued. Of new coins, the 10 mil piece, equal to rather less than 2½d., would be of nickel, and would correspond in value to the American nickel; while the bronze coins would represent 4, 2, and 1 mils respectively. It is not deemed expedient to have a 5 mil piece, though this would be the logical denomination in a decimal system, for its use would greatly upset the everyday transactions in small amounts. As regards the slight variation in value between the farthing, half-penny, and penny, and the 1, 2, and 4 mil pieces respectively, the bankers consider that it would cause no inconvenience in ordinary trade, especially nowadays when the purchasing values of the common coins fluctuate comparatively widely. Some adjustments would be necessary in connection with the postal rates, penny-a-mile fares, calculating machines, etc., but these should not cause overwhelming difficulties. The bankers do not wish the change to be made in time of war, and they recommend a fairly long period of notice in order to conduct educational campaigns. As far as our own views go, we accept the proposal gratefully, as constituting a thin end of the wedge for the introduction of the metric system of weights and measures. The bankers expressly state that this comparatively trifling alteration in the British money system will inculcate in the populace an appreciation of the decimal system generally, and will therefore pave the way for the greater subsequent move. At one time we were hopeful that a universal system of coinage could be introduced, concurrently or subsequently to the adoption of the metric system of weights and measures. But this is not to be, at any rate under present conditions.

Pump-Dredging versus Bucket-Dredging.

In this issue we print an article on Australian practice with the pump-dredge, written by a master of the subject, Mr. Arthur H. P. Moline. The author gives particulars of the results obtained at the Y. Water tin mine in New South Wales, and at the Cock's Pioneer mine in Victoria, which contains both gold and tin, and he discusses the range of usefulness of the application of this method of dealing with alluvial deposits. The article may be suitably considered side by side with Mr. Harry D. Griffiths' papers on bucket-dredging in Malay, published by us earlier in the year, and now reprinted in book form. Pump-dredge practice has previously been described in our columns by Mr. Alexander Colledge, who in the issue of July 1913 gave particulars of the North Tambun plant, Perak, and by Messrs. J. E. Macnamara and H. E. Fern, who gave particulars of the plant at Goss Moor, Cornwall, in the issue of July 1912. We would remind readers that the relative advantages of bucket-dredging and pump-dredging were discussed in lively manner at a meeting of the Chamber of Mines of the Federated Malay States held in November, when a paper was read by Mr. A. C. Perkins on tin-dredging practice in the Malay. We printed a precis of this paper in our January issue, and abstracts of the discussion thereon by Messrs. J. M. Newman and T. R.

A. Windeatt in our March issue. Mr. Newman spoke in favour of the pump-dredge, and Mr. Windeatt devoted his remarks to losses in bucket-dredging. We have recently received a copy of Mr. Perkins' reply to the discussion, and in it he reviews some of the advantages and disadvantages of the two systems. The appearance of Mr. Moline's article in this issue makes it appropriate to discuss his and Mr. Perkins' opinions conjointly.

Mr. Perkins sums up the advantages of bucket-dredging thus, presuming of course that the conditions are reasonably suitable: First, the working cost in the Malay States has been proved to be from 3d. to 5d. per yard lower than with the pump-dredge. Second, the system lends itself more readily to the treatment of large quantities. Third, the method of working is more systematic and entails less dead-work. Fourth, it obviates danger from flooding. Fifth, the tailing is dumped on ground already treated and not on land that may be valuable for subsequent tin production or in other ways. Sixth, the dredge defaces the surface of the country to a much less degree than any other method, and indeed leaves it in good condition for cultivation. Mr. Perkins proceeds to show that, though pump-dredging has been employed at many mines in the Malay during the past ten years, its success has not been indisputable, except at places where the ground is rich; while at two mines, the Tekka-Taiping and Kamunting, the change from pump-dredging to bucket-dredging was attended with highly gratifying results. He quotes specific figures for the operations of the two types of dredge at the Tekka-Taiping, as given by the general managers, Messrs. Osborne & Chappel. Translated into English units, the results are approximately as follows:

	Pump-Dredge	Bucket-Dredge
Concentrate recovered per yard	1·4 lb.	1·3 lb.
Working Cost per yard	7½d.	3¾d.
Working Profit per yard	7¾d.	10½d.
Price per ton realized	£104	£106
Profit per ton of concentrate	£52	£78

It will be seen from this table that the working profit made by the bucket-dredge was 50% greater than that made by the pump-dredge.

Of disadvantages in connection with bucket-dredging there are several, but the extent of their influence offers opportunity for difference of opinion among engineers. For instance, a hard uneven bedrock is troublesome in bucket-dredging. Mr. Perkins gives instances where the buckets can cut limestone pinnacles satisfactorily and deliver the cassiterite to the sluice-boxes without loss, and he also states that in many cases as much cassiterite is left behind on the bottom by the pump-dredges as by the bucket-dredges. Generally, however, engineers will agree with Mr. Moline that a hard uneven bottom is a distinct disadvantage, and that its adverse influence against deciding in favour of the bucket-dredge depends on the relatively preponderating influence of other conditions. Hard bedrock is not the only physical enemy of the bucket-dredge, for timber and boulders are equally objectionable. It is true that powerful dredges are not greatly affected by their presence, but the extent of the ground does not always warrant the construction of super-dredges. Then again the presence of sticky clay is against the bucket-dredge. For one thing it thrusts the function of digging on the buckets as well as that of lifting, thus casting a great strain on the buckets and on the structure, as well as causing difficulties in keeping the dredge up to its work. The stickiness of the clay prevents much of the cassiterite from being discharged from the buckets, and also from passing the screen and arriving on the sluice-boxes. Another point always open to argument relates to the adequacy of the sluice-boxes that can be carried on a floating dredge. Obviously the area of the sluices can be easily extended to meet the requirements when the sluice-boxes are built on the ground. The sluice-area on a bucket-dredge is limited, but by means of double banks the area is often substantially increased, although naturally there must be a maximum weight that the dredge can carry. Another point to be remembered is that the buckets often spill part of their contents during their travel up the ladder. As Mr. Moline says, the relative advantages of bucket-dredging and pumping offered topics for an almost endless discussion. The general deduction from experience is that it will not pay to pump any ground yielding less than 1s. per yard, and that low-grade ground must therefore be treated by bucket-dredge or left alone. If the ground is richer and at the same time extensive and easy to lift, the bucket-dredge will hold sway. Mr. Moline's view is that when there are obstacles to the simple treatment by bucket-dredge, such as difficulties in disintegrating and the presence of serious obstructions, the use of the pump-dredge should be seriously considered whenever the average content is worth more than 2s. per yard.

For the benefit of our lay readers we ought to add as a postcript that the question of dredging alluvial ground, whether by bucket or pump, only arises where there is no natural source of high-pressure water and no means of disposing of the tailing by gravity. When favourable conditions of this sort occur, ordinary sluicing is employed, and the cost per yard may be as low as 2d. For a general outline of hydraulic methods of mining our lay readers should consult Messrs. N. B. Knox and C. S. Haley's articles published in our issues of February, March, and April, 1915; they should also read Mr. J. J. Garrard's paper on sluicing methods in Swaziland read before the Institution of Mining and Metallurgy in February, and abstracted in our issue of March.

"The Gold Deposits of the Rand."

Though the Rand has been worked for thirty years, no theory of the origin of the gold has yet been evolved that finds universal acceptance. Geological evidence often depends on small indications, visible only to those who wish to see them. A particular item of evidence may appeal to an independent geologist, but not so readily to the engineer who has certain financial interests at stake. We are of course not referring to wilful distortion of facts, but to the unconscious influence which personal inclinations exercise, when they are founded on preconceived scientific ideas or on responsibilities in regard to money invested. On the Rand the services of the economic geologist have not been required to any great extent, for the reefs have never been lost for long. Mines, like human beings, do not require the physician when they are healthy or the diagnosis simple. This, however, is not the only difficulty in the way of the geologist who wishes to study the Rand formation, for in addition the vast extent of the deposit usually precludes any one individual from studying it as a whole. Even Dr. E. T. Mellor, who spent five years mapping the stratigraphy of the Rand, confessed that his opportunities for obtaining and confirming evidence were inadequate. Then again, the great size of the deposit makes it possible for the mines to create so great a reserve of ore that the average content over millions of tons can be calculated, and thus the actual mode of occurrence of the gold is effectually masked as far as the outsider is concerned. To the investor this tonnage and average is more or less comforting; to the geologist it is annoying. Lastly, we have the disinclination of the controllers of the industry to encourage too close an examination by strangers, for fear some unprincipled person should use the infiltration theory in an unfair way. The controllers are probably comparatively indifferent at present as to whether the scientists adhere to the placer theory or to the infiltration theory, for the payable nature of the ore depends as much on the engineering conditions as on the persistent high content of the orebodies. The placer theory would no doubt encourage them to hope for rich ore below an obstinately barren patch, though the alternations of rich and poor sections in the Indian mines, where there is no suspicion of a placer theory, are equally effective in consoling the directors and the shareholders of the companies interested in that district.

These few words are intended as an introduction to a review of Mr. C. Baring Horwood's book "The Gold Deposits of the Rand," and will serve to show the frame of mind in which we approach all these discussions as to the origin of the Rand gold. The book is an expansion of the articles which appeared in the *Mining and Scientific Press* four years ago, and it is issued in excellent style by Charles Griffin & Co., the publishers of so many works by Associates of the Royal School of Mines. Let us say at the outset that Mr. Horwood is an upholder of the lode theory in its application to the Rand deposits. He is the only extensive writer on the subject who combines geological knowledge with long underground experience gained as general manager of mines on the Rand. His writings show him to be an earnest student, a stickler for accuracy in detail, and to be quite free from the influence of prejudice or self interest. We are aware that his deductions are not accepted by all the geologists in South Africa, where, we regret to say, the unrestrained personal element gets the upper hand occasionally and tends to confuse the lines of argument. But the serious student will read his statements with respect, and will recognize the value of his contribution to geological science.

Briefly, Mr. Horwood holds that the banket is not essentially different from the ordinary gold-quartz lode which has been filled with metal or mineral by ascending solutions associated with intrusions of igneous masses. He is of opinion that the intrusion of the multitude of diabase dykes on the Rand was the means of opening deep-seated channels up which the gold-bearing solutions ascended. His argument is that these dykes belong to the long period of igneous activity to which the Ventersdorp diabase is due, the latter being an overlying lava-flow of more recent date than the conglomerates of the Witwatersrand System; and, that the faulting and troughing of these conglomerates were caused by the sinking of the strata as the lava welled up from below. The diabase dykes are known to contain gold, averaging sometimes as much as $1\frac{1}{2}$ dwt. per ton, so that evidence is at hand suggestive of the source of the gold. Other geologists have argued in the opposite direction; they are not satisfied that there is such an amount of enrichment in the neighbourhood of the dykes as is customary in gold lodes generally, and they contend that the gold in the diabase was absorbed from placer deposits at the same time that the gold of the banket was dissolved from these placers by, and reprecipitated from, barren solutions. This question of the degree of richness of the gold in the banket in the neighbourhood of dykes is, in fact, the immediate cause of the rejection of the infiltration theory on the part of many investigators. Mr. Horwood has, however, collected a great deal of evidence tending to show enrichment near the dykes; but he also points out that occasionally there may be impoverishment. He states that personally he always worked on the principle that, at and near the junction of the sites of fissures with the lodes, there may be, though not necessarily, some change either for better or worse in the grade of the ore. Following Mr. Horwood further, it may be said that variation in the grade of ore due to dykes is a local effect, and its presence or absence is no argument against such sites marking a portion of the system of channels whence those mineralizers ascended that are responsible for the contents of the lode as a whole. Mr. Horwood points out that there are many instances in lode mining of similar phenomena where there is ample proof that the dykes or faults furnish the present day evidence of former trunk channels of mineralization. In the case of the Rand, he proceeds, fissures which cut the conglomerates at the greatest depths, not yet reached by mining operations, would have formed the main trunk channels, for the reason that, owing to the greater length of their more open porous upper portions, which consist of those conglomerate beds that have acted as their upper extensions, they would have supplied the easiest communication toward the surface. We quote Mr. Horwood at this length on the connection of the gold with the dykes, as this is a crucial point of the theory of infiltration, as we have already mentioned.

Mr. Horwood has investigated the nature of the pyrite "pebbles," which he shows to be metasomatic replacements in which pyrite and gold have been deposited contemporaneously. These "pebbles" are always near dykes, and the amount of gold contained in them is directly proportional to their proximity to the dykes. These pyrite "pebbles" are not, however, the only indications of deep-seated action, for carbon is also found in proximity to the dykes, and Mr. Horwood shows its connection with the diabase intrusions.

Mr. Horwood elaborates another argument in favour of the theory of lateral flow of solutions introduced as a result of the intrusion of the dykes. The whole of the Witwatersrand System is more or less auriferous, and the degree of the gold values depends on the interstitial accommodation. Thus the coarser the constituents of the conglomerates the greater the amount of solution that has access and the greater the amount of gold deposited. Moreover, whenever a coarse layer of conglomerate is underlain by an impervious band we would expect the accumulation of gold to be the greatest. This happens to be the fact in the case of all the payable reefs. Following up this line of argument, Mr. Horwood shows that rich patches in one reef usually correspond to poor patches in another reef, when the plans of the two reefs are superimposed. This condition is typical of other gold deposits where there are parallel lodes. A new argument advanced by Mr. Horwood against the placer theory relates to the quality of the gold. He points out that one of the chief characteristics of placer gold is its exceptional purity, whereas the Rand bankets are in reality silver-gold deposits, the bullion containing 10 to 12% of silver.

It is not possible for us to do more than indicate the chief arguments and to encourage readers to study the book closely. A year and a half ago we quoted the views of Dr. E. T. Mellor, the most recent advocate of the placer theory, and in July 1916 we revived De Launay's theory that the gold was precipitated from the ocean contemporaneously with the original constituents of the conglomerates, so that readers now have in handy form the exposition of the three main theories. Some day another theory may be evolved. For instance, a better explanation of the origin of the gold in some placers may be promulgated, ascribing its existence as being due not to the water transport of the noble-metal constituents of older rocks, but to chemical action, either contemporaneous or later. There is much difference of opinion among investigators, and there has been little opportunity as yet for independent economic geologists and mining engineers to weigh the relative merits of the various theories. Whenever the outsiders are given a chance to judge for themselves, some other interpretation may be evolved that will reconcile previous antagonisms.

REVIEW OF MINING

Introductory.—The celebration of the Fourth of July in the Old Country was the greatest event of the month. The old sore spots are cured, and as a cartoonist has said, Jonathan can now celebrate his freedom by rejoicing in his "freedom to come back." The calmer atmosphere in Russia and the recommencement of hostilities by Brusiloff have infused a more cheerful feeling here, in spite of submarine activity and raids by aeroplane. The statement that Russia will hand the eastern Siberian mining industry to American supervision is too vague to discuss at present. The metal markets, except those for tin and silver, are now under firm control by the Government. The price of tin has receded from the highest recorded a month ago, but is still abnormal and is likely to remain so.

Transvaal.—The dividends paid by the mines on the Rand for the first half of 1917 aggregated £3,304,401, as compared with £3,656,894 during the first half of 1916. The year 1913 saw the zenith of Rand profits, for during that year £8,111,310 was distributed. The number of dividend payers now is 35, as compared with 39 a year ago. East Rand Proprietary, New Kleinfontein, and Randfontein Central have dropped out of the list, the first named on account of poor results, the second because capital is required for the new plant, and the third on account of the reorganization instituted by the new controllers. About 39% of the total distribution comes from mines in the Far East Rand. Modder Deep shows the greatest advance in the rate of dividend, the amount being 40% for the half-year as compared with 30% a year ago.

The life of the Village Main Reef is estimated by Mr. H. Stuart Martin at three years. For an old and nearly exhausted mine, the performance during 1916 was excellent. The yield per ton milled was 28s. 9d. and the working cost 19s. 1d., the former being 4s. and the latter 2s. 7d. less than in 1915. The upper workings continue to provide unexpected supplies of ore, and in some parts Main Reef can be mined at a profit with the present low costs.

Robinson Deep is a mine belonging to the Consolidated Gold Fields, and is surrounded by others of the Central Mining group, Crown Mines, Robinson, Ferreira, and Village. A year ago the Booysens property on the dip was absorbed and its development begun. Mr. C. D. Leslie reports that 4,540 ft. has been driven on the Main Reef Leader, averaging 7·1 dwt. over 56 inches, and 4,500 ft. on the South Reef, averaging 6 dwt. over 48 inches. The most recent exposure is in drifts from a cross-cut from No. 2 incline shaft on the 35th level. Here the assay-value of the ore is higher than the average. In the drift on the Leader, 100 ft. averaged 10 dwt. over 57 inches, and in that on the South Reef, 50 ft. averaged 16 dwt. over 60 inches. This spot is in the centre of the Booysens section.

The fortunes of Knight Central have been in the balance for the past two years. At one time the results of development below the dyke were such as to revive interest and to create a temporary boom, but it was soon recognized that a single high assay-value was no basis for solid business. It has now been decided to suspend shaft-sinking and to limit the development to the payable faces. The remaining ore will be stoped and milled as long as it pays to do so. The amount of development below the dyke has been considerable, the total having been 23,793 ft. Of this 13,602 ft. was on the reef, and has disclosed 760,700 tons of ore averaging 3·6 dwt. over 58 inches. The payable portion was only 56,300 tons averaging 5·85 dwt. over 61 inches. This mine has been one of the failures of the Rand, for since the start of milling in 1909, only one dividend, of 5%, has been paid on the capital, £900,000.

Rhodesia.—The output of gold during May was worth £299,271, as compared with £296,977 in April, and £323,783 in May 1916. The Falcon showed a notable increase, but on the other hand the returns from the Lonely Reef were lower. The Shamva figures were also higher than those for April.

At the annual meeting of the British South Africa Company the financial position from the shareholders' point of view was not of the same relative importance as it has been at earlier meetings. The part taken by the country in the war and the question of future administration were naturally given greater prominence. Rhodesia is having to bear some share of the cost of the war, and the necessary funds are supplied by the Home Government on loan. In all probability the general reorganization of South and Central Africa after the war will provide the opportunity for varying the relations between Rhodesia and the United Kingdom.

As recorded elsewhere, the Amalgamated Properties of Rhodesia has lost its appeal in the action against the Globe & Phœnix, and the case is to be carried to the House of Lords. In the meantime, the directors, and the largest shareholder, Mr. H. S. Foster, have decided on a reconstruction scheme for the purpose of raising additional capital, and the shareholders have adopted it. Each holder of an old 4s. share will receive a new 3s. share credited with 2s. paid. As there are 3,767,950 shares issued, the reconstruction should yield a fair amount of money. Mr. Foster and his friends have underwritten applications for 2,000,000 new shares. If the claim to a portion of the Globe & Phœnix output finally fails, the company will have land assets in Rhodesia to fall back on. These under capable management should prove of value.

West Africa.—The output of gold during May was worth £121,104, as compared with £123,825 in April, £132,976 in May 1916, and £142,123 in May 1915.

Angola.—Specimens of bituminous shale, from Quilungo in Portuguese East Africa, have been brought to Cape Town, and examined by Dr. Marloth. The shale is called "coal," but as the volatile matter is 40% and the ash 25 to 30%, that name does not seem suitable. On distillation, 70 to 75 gallons of crude oil can be extracted per ton, the remainder being a coke that averages 50% carbon. The shale bed is 6 ft. thick, can be worked from outcrop, and is undoubtedly extensive. It is situated 7 miles from Zenze, a railway station 90 miles inland from St. Paul de Loanda. Prospecting and mining licences are obtainable at Lisbon.

British East Africa.—The war has seriously interfered with the business of the Magadi Soda Co., a company owning deposits of soda at Lake Magadi, and controlled by the Central Mining and the Shell Oil people. The railway connecting with the coast has been in the hands of the military, and few deliveries could be made. The refining works at Irlam, near Manchester, were commandeered by the British Government, and the company will have to wait for some time after the war before a foothold can be gained in this country. Such shipments as are made from Africa go to India and the East, and here again the Government affords no assistance. The directors give utterance to a protest with regard to the treatment meted out to them. Those of us who know something of the methods of the North of England alkali trade may be permitted to express our sympathy.

Australasia.—The directors of the Mount Lyell Mining & Railway Co. have decided to suspend the practice of publishing half-yearly balance sheets and reports. In future yearly reports will be issued, covering each twelve months ending September 30. Interim dividends will be paid in June, and final dividends in December. During the half-year ended March 31 last, the ore treated amounted to 129,664 tons, of which 46,060 tons averaging 6·6% copper came from the North Lyell. With regard to recent developments, the northern extension of the South Lyell ore-body is opening up excellently on the No. 9 level. In North Lyell, diamond-drilling has exposed 32 ft. of ore at the 850 ft. level, 47 ft. at the 1,000 ft. level, and 20 ft. at the 1,200 ft. level.

At the meeting of shareholders in the Zinc Corporation, Mr. F. A. Govett, the chairman, gave some particulars of subsidiary metallurgical interests. Of these, the experiments on the Hall sulphur process have been suspended, only temporarily it is hoped. The Chloride Syndicate's process is being closely investigated by Mr. A. L. Queneau. Shares have been acquired in the Electrolytic Zinc Co. of Australasia. The experimental plant of the latter is producing 250 to 350 lb. of zinc per day. The first unit of the working plant, estimated to produce 10 or 11 tons per day, is under construction, and if all the parts are delivered to time, should be in commission in August.

Owing to a breakdown of plant, the output of the Hampden Cloncurry copper mines during the half-year ended February 28 was below normal. The furnaces treated 46,856 tons of material, for a yield of 3,289 tons of copper, 1,157 oz. gold, and 23,418 oz. silver, as compared with 56,119 tons of ore, 3,673 tons of copper, 1,277 oz. gold, and 28,009 oz. silver during the previous half-year. A decrease in the price obtained for the copper and increased labour charges caused a serious reduction in the working profit, the figure being £64,539, as compared with £165,224 during the former period. The reserve is estimated at 284,200 tons averaging 7·1% copper, as compared with 299,000 tons averaging 7·4%.

The Great Boulder mine at Kalgoorlie continues to exhibit wonderful vitality. Mr. Richard Hamilton, the manager for so many years, has always taken care not to be deceived by the irregular occurrence of the rich ore minerals when estimating his reserve, an experience that has happened to more than one manager in the district, much to his chagrin. In spite of the fact that no more ore is expected below the 2,500 ft. level, additional ore continues to be brought into the reserve. During 1916, 120,900 long tons was added in this way, while 175,787 tons was extracted from the mine.

The reserve now stands at 439,677 tons averaging 14·68 dwt. The total treated during the year was 19,737 tons less, and the output of gold £58,198 less, than during the previous year, owing to the suspension of operations for three weeks on account of the labour troubles at Kalgoorlie in February a year ago.

The Briseis Tin company's properties in Tasmania yielded 466 tons of tin concentrate during 1916. At Krushka's Flat, 280,600 cubic yards was sluiced for a yield of 357 tons, being 2·86 lb. per yard; at Ringarooma, 354,700 yards was sluiced for a yield of 88 tons, or 0·55 lb. per yard; at the Mutual Hill property 105,000 yards was sluiced for a yield of 21 tons, or 0·45 lb. per yard. The concentrate was smelted by the Mount Bischoff company, and the metal extracted, 330 tons, was sold for £60,643. As regards reserves, the ground remaining at Krushka's Flat is estimated to contain 560 tons of black tin, and on the Ringarooma sections within the limits of the present scheme of operations the content is estimated at 3,845 tons. The company also operates the Wallace gold property in north-east Victoria. During the year gold worth £21,375 was obtained by dredging 1,219,200 yards, being a yield of 4·2d. per yard. The company's profits from the two ventures totalled £32,517, of which £9,001 was written off for depreciation of plant and investments, while £15,000 was distributed as dividend, being at the rate of 2½%.

New Caledonia.—French authorities give the shipments of nickel ore from New Caledonia during 1916 at 30,679 tons averaging 5%, and of nickel matte 4,935 tons averaging 45% nickel. The exports of ore have greatly fallen off since the war, owing to lack of sea transport. The figures for 1915 were 48,576 tons, for 1914, 94,154 tons, and for 1913, 93,190 tons. The shipments of matte during these three same years were 5,529 tons, 5,277 tons, and 5,893 tons.

Burma.—Though the internal relations of directors and shareholders are not everything to be desired, the Mawchi tin and wolfram mine is being effectively worked by the manager, Mr. Harold Geeson. The belated report for the year ended July 31, 1916, shows that 12,382 tons of ore was milled, and that the yield of concentrate was 365 tons, assaying 31·4% WO_3 and 33·4% metallic tin. Since then the rate of output has been increased, and the last return was 45 tons for May. The reserve is estimated at 58,095 tons, with other ore partly developed. The directors contemplate a further expansion of the scale of operations.

The Burma Ruby Mines company has just managed to keep going during the last year without any substantial financial loss. The ground washed measured 1,118,023 loads, and the stones extracted were valued at £40,842. Half of the yield came from the new Kathé property. The sales during the year were £40,963 locally and £8,760 in London. The revenue account showed a loss of £329.

Malay.—The Tekka is one of the most economically managed mines, and about 65% of the income is net profit. The last yearly report shows an income of £49,400 from the sale of 491 tons of tin concentrate, total costs £15,512, and the allowance for depreciation £3,000. The company also received £3,560 from its holding in the Tekka-Taiping. The sum distributed as dividend was £30,000, being at the rate of 37½%. The mine has been highly profitable since its start in 1908, and it has a prosperous future before it. Mr. James Wickett, of Redruth, is a proud man in his capacity of controller of mines like the Tekka and the Gopeng.

Kent.—We have on many occasions referred to the adverse fortunes of the coal companies operating in south-east Kent. A new move for the regularizing of finances has been taken in connection with the Kent Collieries, Limited, and the Channel Collieries Trust, Limited. These two companies are to be amalgamated under the name of the Channel Steel Company, Limited. The iron-ore beds in the area controlled by these companies are of potential value. The Middlesbrough iron and steel firms, Bell Brothers, Bolckow Vaughan, and Dorman Long are interested financially in these companies, and when the suitable time arrives they may be expected to develop the deposits. It is admitted that the iron ore is not of the same class as the ores treated by these Middlesbrough companies at present.

Cornwall.—An extension of the lease has been obtained by the company operating the Porkellis tin mines in the Wendron district. Mr. R. Arthur Thomas, one of the directors, estimates the proved ore at 80,000 tons. The mill has been improved and extended, and crushing is expected to begin next month.

A movement is on foot to form a selling trust for the various china-clay producers in Cornwall and Devon. Each producer will be represented in the business of this trust by votes proportional to his individual output. Until the last few years the china-clay business was a sort of close corporation, and there was full agreement as to policy among the several producers, of whom the Stockers, Loverings, and

Martins were the most prominent. Recently the mining of clay has been greatly expanded, and many new people have gone into it. The function of the new organization will not be confined to the disposal of the products, for in addition a research department is to be established. It has to be remembered that the manufacture of pottery is far from providing the only outlet for china-clay, for its use in connection with paper-making and the textile industries is extensive.

Canada.—The report of the Dome Mines for the year ended March 31 shows a considerable fall in the ore reserves, which, on that date, were estimated at 2,250,000 tons containing gold worth $11,979,000, as against 2,600,000 tons and $16,120,000 the previous year. This fall is partly compensated by the higher assay-values disclosed at lower levels by diamond drilling. The gross receipts were $2,171,785, and the net profit after allowing for depreciation $731,079. The dividends called for totalled $800,000, leaving a deficit of $68,921. The average yield of the 459,530 tons treated was $4·72 per ton. The directors are considering a change of policy, which will probably be in the direction of curtailing production until labour conditions improve and devoting more attention to development. At the Hollinger, there has been a steady decrease in the output since December on account of labour scarcity. Mr. N. A. Timmins, the president of the company, has announced that the dividend now due will not be paid, as the directors are contemplating restriction of work to development with a view of putting the mine in a condition to increase the output when a supply of efficient labour becomes available. Silver-mining at Cobalt is not so seriously affected by the scarcity of labour as the gold centres, as the miners give Cobalt the preference on account of the higher bonuses granted based on the present high price of silver.

On May 31 a judgment was rendered by Mr. Justice Middleton at Toronto in several actions brought by farmers and others in the Sudbury district against the Canadian Copper Company and the Mond Nickel Company for damages on account of injury to their properties from smelter fumes. Six actions were consolidated for one trial, which extended over a period of 34 days, without a jury, with special sittings at Sudbury and Toronto. The judge awarded damages in amounts varying from $500 to $1,400 against the companies, but he refused to grant an injunction stopping the operations causing the nuisance. His ground for this course was that the interests of the community are paramount. He could not, in these days, destroy the Sudbury nickel-mining industry.

United States.—An echo of earlier days comes from Marysville, Montana, where the St. Louis Mining & Milling Co. has reopened the Drumlummon mine. New mining and metallurgical plant has been provided, and the output is 125 tons per day. This mine was floated in London by the Montana Company in 1883. Mr. R. T. Bayliss was resident director, John Darlington was consulting engineer, and Henry Bratnober was superintendent. The success of the mine induced the St. Louis company, owning property adjoining, to institute proceedings under the law of extra-lateral rights. After weary legal wrangles extending over years, the St. Louis company acquired the Drumlummon by compulsory purchase.

Labour strikes are threatening in the United States, owing to the agitation of certain labour unions in districts where men of enemy-alien sympathies are in large numbers. The Arizona copper producers are having trouble. To what extent the output will suffer is not yet quite clear, but the outlook is serious.

Mexico.—Owing to the rapid increase in cost of materials and labour in Mexico, a large part of the ore reserve at the Esperanza gold mine is now unpayable, and operations will probably have to be suspended before long. At the beginning of the present year, the reserve was estimated to be 112,000 tons, of which 54,000 tons, averaging $9·00, was in the San Carlos and Descubridora veins, and 58,000 tons, averaging $4·00, was low-grade ore and old filling. It will not now be possible to treat this low-grade material. No new ore has been discovered recently, so that this notable mine is near its end. We published an account of the property and its history in the issue of October 1909.

Spain.—The Esperanza Copper & Sulphur Co. reports that owing to difficulties of sea transport, shipments of pyrites cannot be made regularly, and stocks are accumulating. It is thought prudent, therefore, not to pay the usual interim dividend. The company has been at law with Matheson & Co., who were from 1906 to 1916 its commercial agents for the disposal of the products. This firm brought an action to recover commission on deliveries made after the termination of the contract but arranged for while the contract was in force. The company claimed that under these conditions such commission was not due. The judge, however, decided that these deliveries were covered by the contract and that therefore the commission must be paid.

AUSTRALIAN PRACTICE IN PUMP-DREDGING

By ARTHUR H. P. MOLINE.

The author gives his experience of the system of treating alluvial deposits containing tin or gold, or both, whereby the ground is broken by a monitor, and raised by a gravel-pump erected on a floatable pontoon, to sluice-boxes at the side of, or in, the paddock. Results at Y. Water and Cock's Pioneer are quoted.

THE PROPERTIES DESCRIBED.—Mention in the mining press of the Australian type of centrifugal pump sluicing plant has not been, so far as I am aware, any more than of a casual nature, so that although the process is only of limited application, those engaged in hydraulic mining may find the following notes of interest. They embody a general description of the work and of the plant employed, with special reference to two of the larger plants still in operation, with which I have been associated. These two plants belong respectively to the Y. Water Tin Company and the Cock's Pioneer Gold & Tin Mines.

The Y. Water property is situated on the New England tableland, 450 miles by rail from Sydney, New South Wales, in a country having an excellent climate with an annual rainfall of about 28 inches. The ground is about 40 ft. deep, resting on a decomposed granite bottom, and carries 1 to $1\frac{1}{2}$ lb. of black tin per cubic yard. In most places the upper half is very hard, generally requiring to be broken up with explosives, and occasionally even having to be shot from the face. During one period of six months when the whole of the ground worked was very hard, nearly 20 tons of explosive was used. A typical vertical section of the ground would consist of a foot of surface soil, then cemented sand, and below that some pipe-clay which is sometimes very hard; then more sand, either cemented or friable, and another band of pipe-clay, and then from a few inches to a few feet of wash, which is seldom very coarse. The surface soil carries a little ruby tin, and wherever there is sand, tin is usually found. Nearly half of the output of tin comes from the overburden, and the balance from the bottom wash. Much of the tin is very fine, and the satisfactory recovery gave much trouble at first. This ground makes a large proportion of slime, which also gave trouble until the importance of the matter was recognized, and extensive settling areas were provided. The slime settles rapidly, but does not consolidate for many months. Before sluicing was commenced, the property was worked for many years by underground mining. Tributes were let to small parties of working miners, who sank shafts indiscriminately, driving and blocking

MOVING THE PONTOON AT COCK'S PIONEER.

The sluice-boxes shown are mounted partly on another pontoon which is independently floatable.

Moving the Pontoon at Y. Water.

The sluice-boxes are shown at the left of the picture. and are built on the ground adjoining the paddock.

out as much of the wash as they could get at from the bottom of each shaft. Winding was all done by windlass, and along the drives the wash was dragged in boxes or shovelled back, no trucks being used. It apparently paid them better to sink numerous shafts than to transport the wash any distance underground There was very little water to contend with, but with no regular system of mining and a total absence of surveys, the extraction of the wash was by no means complete.

The Cock's Pioneer property is at Eldorado, about 150 miles north-east of Melbourne, Victoria. It enjoys the average Australian inland climate, with an annual rainfall of about 25 in. The deposit is an exceedingly large one, more than 200 ft. deep, lying in a granite valley. There are five distinct deposits of wash, one on bedrock, the others about 30, 50, 70, and 90 ft. respectively below the surface. Each of these four upper floors rests on a false bottom of black clay, and the remainder of the ground is granite drift, mostly blackish in colour, owing to the large amount of organic matter present. Over the natural surface is spread a thickness of 8 or 10 ft. of mining debris brought down by the creek, which after rain is of some size. The creek in its natural condition meanders about over a width of 600 ft. or more between two terraces. Before pumping was commenced an embankment was made confining the water to the southern side. In such a case as this the safe and economical handling of the creek is a matter of the greatest importance. This property also has been extensively mined, the earliest work having been done about the year 1858, and underground mining was carried on more or less continuously up to about 1900. This class of mining was confined to the lowest deposit of wash and to the 70 ft. floor, but the extraction of wash was by no means so complete as at Y. Water. Considerable areas of virgin wash have been met, especially during the last few months work. Each floor of wash carries gold and tin in the proportion of about 75 ounces of gold per ton of cassiterite, the latter having an assay value of about 73% metallic tin. The 30, 50, and 70 ft. floors are being pumped. The 90 ft. floor is not of much value. The lowest floor is quite beyond the range of pump-dredging, though I have heard the question seriously considered. The water supply is ample, and the problem of the disposal of debris is not so difficult as is often the case. The chief drawback is that the large amount of clay present prevents the water from clearing quickly, thus necessitating extensive settling area. An area of twenty acres was sluiced by the Cock's Pioneer Electric Gold and Tin Sluicing Co. with a certain amount of success; but their plant proving inadequate to deal with the deeper ground farther down the creek, a new company was formed in 1913 and began operations in November 1914. The first paddock has been completed, and work is now proceeding smoothly on ground yielding a satisfactory profit. Two dividends of 5% each have been paid. The total value recovered to date is rather more than 1s. per yard, and prospecting has disclosed a quantity of about 10 million cubic yards of similar value, though the indications are that the value given by boring will be exceeded by a margin of perhaps three or four pence per yard.

COMPARISON WITH BUCKET-DREDGING.—Pump-dredging is suitable for those deposits which are so situated as to prevent the ground being sluiced with natural fall for disposal of the tailing, but which are not adapted to bucket-dredging. If the ground to be worked is cemented or full of large stones or timber, making bucket-dredging difficult, it would also be somewhat costly to pump, but the latter method would probably be more successful, though in such a case the value would need to be well over one shilling per cubic yard to merit attention. The existence of a hard, and particularly a hard and uneven bottom, is a condition adverse to the use of buckets, but would offer no special obstacle to pumping. In some cases the choice of method may be the subject of debate, but certain considerations are of outstanding importance. Hard uneven bottom is a bar to bucket-dredging. Low values, say 6d. to 8d. per cubic yard, make pumping unprofitable; therefore if such low-grade ground is to be worked at all it must be by buckets. There is another point which I have seldom heard mentioned but which appears to be of importance. It is obvious that practical considerations limit the area of sluice-boxes which can be accommodated on a floating pontoon, whereas with boxes erected on the solid ground, as is the case when pumping, it is possible to extend them both in width and length to any reasonable extent for the purpose of improving the percentage of value recovered. This difficulty may perhaps be overcome by the Neill jig, but so far this apparatus has not been introduced into Australia, nor is there any other compact machine capable of making a satisfactory recovery of value from the large quantity of material which has to be dealt with in any method of hydraulic mining. It is contended by some bucket-dredging men of experience, that the bottom can be cleaned as effectively by buckets as by pumping, but except in special cases this does not appear to me to be possible and certainly not probable. It cannot be denied that a certain quantity of wash is spilled out of the buckets on the way up the ladder, and a certain quantity is lost by the buckets failing to tip their contents quickly. Consideration of these two points, cleaning up the bottom and recovery of value from what is lifted, leads me to the conclusion that while for low values bucket-dredging stands alone, pumping should be adopted if the value is anywhere in the vicinity of 2s. per yard, particularly if there is any difficulty in disintegrating the gold or tin-bearing gravel, or any other obstacle to a reasonably good recovery. This point is probably of more importance in dealing with tin than in the case of gold. The question of the relative advantages of bucket-dredging and pumping can only be touched upon in this article, as it would itself provide matter for a discussion of considerable length.

GENERAL ARRANGEMENT OF PLANT.—As in other classes of mining the plant is modified to suit special local conditions, but the following is a typical arrangement. A centrifugal pump supplies water to the nozzle with which the face is broken down. The mixture of dirt and water flows to a sump called the pump-hole, from which it is lifted by means of a centrifugal gravel pump to the sluice-boxes, which are placed high enough to provide for dumping the tailing, while the water flows to a dam of sufficient capacity to allow the slime to settle. The water is thence led by means of a race or pipe to the intake of the nozzle pump and is used again. The whole pumping plant is carried on a rectangular pontoon, so that it can be conveniently moved from place to place by flooding the workings and floating it, but the pontoon is always landed while pumping is going on. The economical distance from the plant to which pumping may be extended varies with circumstances. With small plants and shallow ground it may be better to move the plant up to the face when the latter is about 250 or 300 ft. distant, while with deeper ground and larger plants the pontoon may be moved forward as much as 600 ft. at a time. When no more ground is within reach a site somewhat larger than the pontoon is prepared by carefully levelling it, marking it with sturdy posts well stayed. All pipe columns and other outside gear are dismantled and all rubbish about the paddock collected and burnt. The workings are then flooded, and the barge floated and pulled by ropes up to the new site, the actual operation of moving taking only an hour or so. The floating barge is then tied to the posts, and a swinging pipe connected from one of the pumps to a line of pipes previously laid up the bank, through which the water is pumped out. The water line is lowered until the barge lands, and enough water is then pumped out to allow the necessary connections to be made to the various pipes and sluice-boxes. The operations of moving may take two or three days in the case of small plants, and up to 10 or 12 days in the case of large ones. Pumping is then resumed, and a dam formed with the tailing as it is deposited behind the plant. In the course of a few days normal conditions obtain and work proceeds on usual lines.

It is seldom necessary to equip a plant with more than one gravel pump, but in deep ground or where a very extensive area of boxes is required, it is a good plan to provide two pumps. One lifts the material to the sluice-boxes, which are erected conveniently close to the pontoon, so that the tailing from the boxes passes to a sump and thence to a second gravel pump which deposits it on the dump. It can be arranged for the second pump to be self priming, which promotes efficient work, and the arrangement generally has many advantages and allows greater flexibility in the location of the plant.

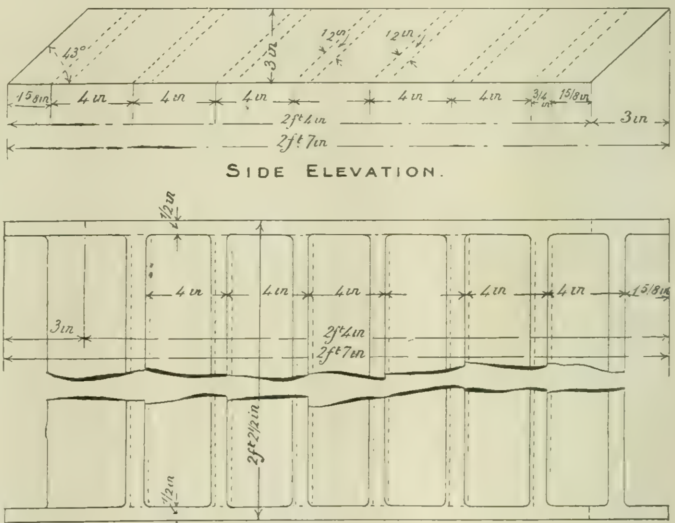
BREAKING THE GROUND.—It is of course desirable that ground to be worked by pump-dredging should be of such a nature as to be capable of being broken down from the face by means of a nozzle, though in some instances ground has to be shot down. The pressures in common use vary from 40 to 80 lb. per square inch, seldom higher. The diameter of the nozzle tips may be from 2 to 6 in., and occasionally even larger. A 5 in. tip with 50 lb. per square inch pressure discharges about 4,000 gallons per minute, which would be the quantity of water circulated through a fair sized plant. The ground from the surface downward for a considerable distance may be hard or cemented, provided that there is a softer layer near the bottom in which the nozzle can bore and so undermine the bank and cause it to fall. The resulting lumps can be broken up with explosives without adding materially to the cost. Thick beds of tough clay are objectionable, as the clay is not good material either to bore with the nozzle or to break up. It also makes a large proportion of slime, which is a disadvantage. If the value in the ground warrants it, the face can be shot down, but this may add 2d. or more per yard to the cost.

The ground having been brought down and broken, the water has then to transport it along the sluice-race to the pumphole, from which it is lifted by the gravel pump. The working grade of the race will be approximately the same as the grade which is adopted for the sluice-boxes. In some cases a concentration is effected in a race or box in the paddock before elevation, but this is unusual. The relative quantities of water and gravel which can be handled depend upon several factors, namely, the physical properties of the ground, the working grade of the sluice-races in the paddock, and the grade of the sluice-boxes. This proportion, by volume, is referred to as the "duty of water," and in the most favourable circumstances may be as good as 11, and with adverse conditions may rise to 30 or 40. A duty of 4 may be obtained in the special instance of removing slime by pumping, but the solid matter in this case is in a very fine state of division. A mixture of sand and loam on a grade of 4% may require 12 to 15 times its bulk of water to move it. The same material on a 2% grade would require practically twice the quantity of water.

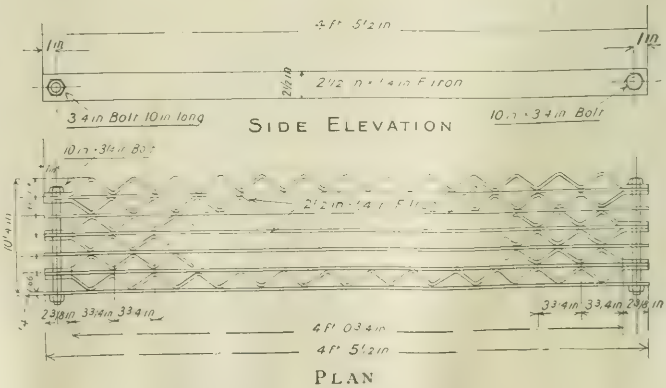
The function of the water from the nozzle is twofold, and this point is to be emphasized, for it is often confused. The water issuing under pressure from the nozzle has to break the ground down from the face, and in hard ground it is often impossible to get enough dirt from the face to keep the plant fully supplied. The race leading to the pump and also the boxes will then be scoured out, and the tailing dump starts to cut down. This is due to an increase in the proportion of water to dirt, though the water could carry more dirt away if it was possible to break it. The removal of the broken material is the second part of the work of the water, and if an ample supply of dirt can be obtained from the face, the quantity raised depends on its physical nature, the quantity of water, and the grade of the race. Many practical sluicemen maintain that high pressure water will carry away more dirt than low pressure water will, but it is a fallacy. When breaking dirt from the face is suspended, and attention is given to "blowing in" the debris lying about the bottom; then high pressure is often useful as the nozzle is turned to face the plant, cleaning up the bottom before it. In this case the actual velocity of the water issuing from the nozzle is utilized to lift the gravel onward. In another case high pressure is necessary, and that is in deep ground where a pressure of 60 to 70 lb. per square inch is required so that the nozzle may be set at a safe distance away from the face. In many cases a supply of water running over the top of the face is of use in helping to sluice away the gravel and to help to fall the ground by filling up cracks and exerting hydrostatic pressure on baulked ground.

While removing overburden it is necessary, in order to keep up a good yardage, to preserve the standard grade in the sluice-race and between the head of the race and the face. This can be done for a distance of say 200 ft. from the pumphole without allowing the working grade to rise above the bottom on which the deposit lies. At greater distances, however, it will be seen that the grade must rise considerably above the bottom, leaving a portion of the ground, and probably the most valuable in place. Having completed sluicing the overburden, it then becomes necessary to "blow in" this remaining portion. The nozzle is turned around more or less to face the plant, and the dirt is partly sluiced and partly blown toward and along the race. The working grade is continuously being reduced by the removal of the material which builds it up, and it will also be found that the material is continually being concentrated, the heavier sand and gravel being left behind. For these two reasons the duty of water is very much poorer during the process of blowing in and brings down the average. From experience of such work I would say that blowing in requires quite 50% and sometimes nearly 100% more water than sluicing from the face with a good fall in the race. Skilful handling of the nozzle is of particular value in blowing in, a capable man being able to reduce the time of the operation very materially. The amount of ground remaining to be blown in depends mostly upon the contour of the bottom, but it is not unusual for blowing in to take about a fortnight after sluicing has been going on for six weeks.

SLUICE-BOXES.—The gold or tin is recovered in sluice-boxes, in which various types of riffles are used. For gold the sluice-boxes are from 4 to 8ft. wide and from 60 to 100ft. long, the depth being 12 or 15 inches. The boxes are made of mild steel plate $\frac{1}{8}$ or $\frac{3}{16}$ in. thick, in 12 ft. rivetted sections, which are bolted together for convenience when dismantling or removing. The joints should be flush inside, with cover plates outside, for convenience in washing down. The riffles in most general use are known as "Curly," Venetian, Hungarian (angle iron), and perforated plates, details of which are shown on the accompanying drawings. Washing down the boxes is carried out usually once a week, sometimes oftener, and need not be detailed. Mercury is sometimes used in the sluice-boxes. The boxes are set on a grade of from 5 to 8%. For saving tin the boxes are of greater dimensions, but are not so steep, the grade being from 3 to 4%. The smaller plants are usually equipped with a line of boxes say 10 ft. wide, 18 in. deep, and 120 to 150 ft. long. The sluice-boxes at Y.



Details of Cast Iron Venetian Riffles.



Details of "Curly" Riffles.

Water for dealing with 100 cubic yards of dirt per hour were 180 ft. long, 3 ft. deep, and were divided into four sections, each 10 ft. wide. This plant has been enlarged to treat 130 cubic yards per hour, and the boxes now have a total width of 55 ft. This great width is unusual, but I am of the opinion that better recoveries would be made if wide boxes were in more common use, say about 10 ft. of width for each 1,000 to 1,200 gallons of water per minute.

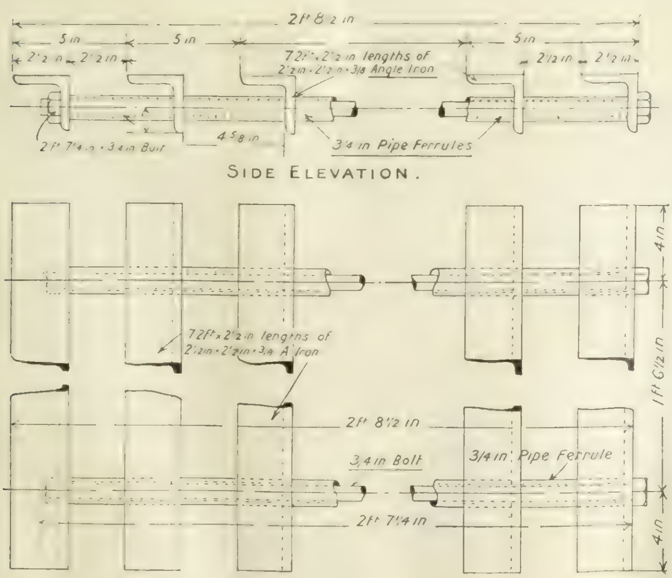
The tin is saved in a bed of sand, which is retained in the boxes by means of timber riffles usually about 3 by 2 in. placed transversely across the box. Vertical cleats are fixed on each side of the box at intervals of from 10 to 20 ft. and the riffles are thus held in position against the flowing water. When tin becomes concentrated in the sand and begins to find its way toward the tail of the boxes, another set of riffles is placed behind the cleats, retaining another layer of sand in which to collect more tin. It may take from four to eight weeks to fill the boxes with this preliminary concentrate, and then all available hands are employed to work the sand with shovels, while clean water is pumped to the head of the boxes. The riffles are drawn one by one until more or less clean tin is left on the floor of the box. This is then removed to a bin for despatch as required to the tin-dressing plant. These boxes require constant attention, one man being on duty in each box. To run down a set of large sluice-boxes may take 30 men two full shifts, and it usually involves a stoppage of sluicing for five or six shifts.

At Cock's Pioneer the ground carries about $\frac{1}{4}$ lb. of tin per yard together with about a shilling's worth of gold. As the tin contents are relatively small, a compromise between the two methods of recovering the values has been adopted. Three boxes, each 4 ft. 6 in. wide, are provided, two being in use while one is available for washing down. Gold riffles are used, and the total length of each run of boxes is 150 ft. As soon as tin is observed making its way toward the tail, the boxes are washed down, delay being minimized by utilizing the spare box. This type of sluice-box can usually be left to look after itself, and washing down, though frequent, can be done at small cost.

A comparison between these two cases, Y. Water (1s. 3d. per yard all tin) and Cock's Pioneer (1s. 3d. per yard, 1s. gold, and 3d. tin) is as follows:

		Y. Water	Cock's Pioneer
Approximate Extraction,	Gold	Nil	1s.
" "	Tin	1s. 3d.	3d.
Approximate Percentage of Recovery	Gold	Nil	97
" "	Tin	90 or more	80 or more
Percentage of total working time lost by washing down		7	2
Cost, in pence per cubic yard, of labour in boxes		0·75	0·25

Owing to the quantity of tin to be dealt with, the type of box used at Cock's Pioneer would be quite unsuited to the conditions obtaining at Y. Water, apart from considerations of economical work. Nor do I think it would be worth while to use wide and deep boxes at Cock's Pioneer in order to improve the recovery of tin. At Y. Water the material coming from the pump is passed over a grizzley, the bars being set 1 in. apart. The oversize goes to waste, while the undersize goes to the sluice-boxes. It is frequently necessary to reject the lumps when dealing with tin, whereas in the case of gold and shallow sluice-boxes everything is allowed to pass over the riffles. In cases where the whole of the value is contained in one layer of wash near the bottom of the the deposit, it is possible to pump the overburden direct to the dump, without putting it



Details of Angle-Iron Riffles.

through the sluice-boxes at all, which has obvious advantages.

DISPOSAL OF TAILING. — In opening up new workings, the tailing is deposited where convenient on the natural surface, the embankment being strengthened by means of bushes 6 to 8 ft. in length, embedded with their leaves inward and the stems projecting out. The safe slope of the bank depends upon the nature of the material and the ultimate height to which the bank is to be built. For a height of 40 ft. in sand the slope should not be steeper than about 33° from the horizontal. Advantage is taken of any convenient natural depression for the purpose of making a dam for the settlement of the slime, the water being returned to the nozzle pump through a surface race or a pipe line; though if the contour of the country is unfavourable it is sometimes necessary to install a special pumping plant to return the water. After the first paddock is completed tailing is deposited therein, the coarser material forming a dam across the full width of the old workings behind the plant, and the further end of the paddock becomes the settling dam. On the larger plants upwards of a million cubic yards may have to be dealt with from any one position of the sluicing plant; hence the economical disposal of the debris from sluicing so as to be safe, and at the same time be clear of all future sluicing operations, is one of the most important problems connected with this class of work.

WATER SUPPLY.—In a few cases water is available in such quantity that after being passed through the plant the whole of it can be run to waste. This may lead to trouble in connection with the pollution of streams. In most cases the supply is much too limited to permit such a thing to be done, at any rate in summer. Conditions vary between wide limits, but on an average the available supply of water should be 10% of that which the plant keeps in circulation. In midsummer this quantity may be largely exceeded. Another point to be mentioned is that in some cases there is a considerable amount of soakage always coming into the workings. This is often useful, but means must always be at hand to keep the water level from rising so high as to endanger the plant at such times as the main pumps are shut down for repair and also during holidays. The loss of water is made up of soakage, evaporation, and also the quantity locked up in tailing and slime.

POWER.—Shallow deposits are often worked by means of portable engines. The usual arrangement is to have one engine driving an 8 or 10 in. gravel pump, and two engines driving one or two nozzle pumps, discharging together from 1,500 to 2,500 gallons per minute. Such a plant may deal with 40 or 50 cubic yards per hour in favourable circumstances. The capital cost is relatively low, but working costs would be high, probably in the vicinity of 1s. per cubic yard. The pontoon plants are generally worked by steam, the pumps on the older ones being rope-driven by horizontal cross compound engines. More modern plants, of which the new Y. Water plant is a good example, have the pumps direct-connected by means of flexible couplings to vertical high-speed enclosed-crank engines. This arrangement is more economical and convenient from every point of view, and is now the standard practice for steam-driven plants.

The boilers most in use are internally fired with return tubes, a semi-marine type. The underfired return-tube is a better steaming boiler, and as it has a larger firebox is more suitable for burning firewood, but its use is strictly limited to situations where good feed-water is always obtainable. The feed-water for these plants is frequently contaminated by sluicing operations, and in such cases the underfired boiler is a menace. Water-tube boilers are suitable, but have not been used to any great extent.

The fuel is in most cases firewood, generally eucalyptus of some variety. An average sample will evaporate rather more than 3 lb. of water from ordinary feed-water temperatures per pound of fuel. Certain varieties give results as high as 4 lb., but this is unusual.

Steam-driven pumping plants carried on pontoons are provided with a surface condenser through which the whole of the nozzle water is passed. The nozzle pump thus performs the duty of a circulating pump, and the settling dam acts as a cooling pond. As the water is often rather dirty, even after passing through the settling dam, the condenser should have ample cooling area, and it is customary to make the tubes of large diameter, say 3 in., so that grass, sticks, etc., which may pass the grating at the intake of the return water pipe, should not accumulate on the tube plate of the condenser. Where there is much rubbish, or where the nature of the ground prevents the water from becoming fairly clear in the settling dam, a by-pass is sometimes provided so that the condenser may be cleaned out without ceasing work, the engines being run non-condensing during the process. The air pumps are driven by gearing off the main engines on the older type of plant, but in modern plants using high speed engines an independently driven air pump is used.

A few of the larger pumping plants are electrically driven, and of these the Cock's Pioneer is one. The power plant consists of two Babcock boilers, each having 2,852 ft. heating surface, with 180 lb. working pressure, and integral superheaters capable of imparting 100 to 150° superheat to the steam. The grate area is 52 sq. ft. in each boiler, being extra large to provide for economically burning firewood. The firebars are also of special type, being flat slabs 7 in. wide and 1 in. thick, supported by two ribs underneath and each containing 50 holes about $\frac{3}{4}$ in. diameter. Allowing for the open joints between adjacent bars only about 10% of the grate area is air space, but the bars are proving very satisfactory. The draft gauge shows about $\frac{5}{8}$ in. of water at the base of the stack. The stack is of steel, 5 ft. 6 in. diameter, and 90 ft. high above grate level. The stack is guyed, not being self supporting, and weighs $8\frac{1}{2}$ tons. Two Belliss-Morcom triple expansion engines, each 570 b.h.p., 375 r.p.m., are direct-coupled to two 400 k.w., 50 cycle, 3 phase, 6,600 volt alternators, with exciters on the same shafts. The power house is $3\frac{1}{2}$ miles from the pumping plant, the site being chosen on account of the good water supply available and for convenience in transport of fuel. The power house is situated on rising ground at the edge of a wide flat, all of it alluvium, the bedrock being several hundred feet below. The foundations were therefore made of fairly rich concrete, and heavily reinforced with old 60 lb. rails. The two blocks of concrete side by side, and distant 7 ft. from one another, are also tied together to prevent any tendency to roll. No apparent movement has taken place during two years continuous work. Current is transmitted at a voltage of 6,500 to the pumping plant, and for operating the condenser and water-supply pumps is transformed down to 415 volts. This is a convenient figure, because while the voltage between phases is 415, between one phase and neutral it is 240, a suitable voltage for lighting circuits.

The transmission line, three and a half miles in length, consists of three copper cables carried on poles. The transmission line terminates at a small substation, containing lightning arresters and a set of isolating switches. From here, the current is carried to the pumping plant by means of a three-cored insulated and armoured cable, 600 ft. in length, which is flexible enough to allow it to be led to any required position, or to be carried on floats when the plant is afloat and requires power for pumping out. All the motors in use are of the induction slip ring type. The principal units, that is the nozzle pump motor and the two gravel pump motors, take current direct from the mains at 6,100 volts, the loss in transmission being from 200 to 400 volts, depending on the total load on the line. The smaller motors on the barge, used for service pumps, etc., and the various motors used in the tin-dressing shed, fitting shop, etc., are all supplied with 415 volt current from transformers, of which there are two, one carried on the barge, and one at the terminal house of the transmission line. An automatic voltage regulator is mounted on the power station switchboard, and is set so as to keep the voltage at the pumping plant at 6,100. In any electrically driven plant an automatic regulator should on no account be omitted, owing to the necessity of frequently starting and stopping the gravel pump motors. The high tension motors have been satisfactory in operation, and similar motors have also been used successfully for many years at the Pioneer mine in Tasmania. On both the Pioneer and the Cock's Pioneer the starters and speed controllers are of the liquid type, though differing much in detail. Electrically, the liquid starter is an excellent device, as a gradual variation in speed is obtainable. Certain mechanical faults have appeared in the controllers, which have been rectified, but there is always a certain amount of corrosion taking place at the terminals, which can only be obviated by using water devoid of any trace of a dissolved salt. In the case in question a fraction of a grain per gallon of NaCl in solution has caused quite a lot of trouble. In designing the starter, insufficient attention was paid to making it accessible for repairs. The consequent delays have been overcome by providing stand-by sets of simple construction which, while not suitable for continuous work, can be used satisfactorily for the period required for carrying out the necessary repairs to the regular controllers.

When the Cock's Pioneer plant was under consideration, proposals were made to install direct current motors owing to the wide variation in speed that was required. It was decided, however, to adhere to alternating current, and experience has entirely justified the choice. The induction motor is undoubtedly an excellent machine for the trying conditions of mining work, and the ease with which alternating current may be transformed either up or down, thus providing for economical transmission, and also for all necessary uses, gives it great advantages. The loss of electrical efficiency occasioned by running induction motors at low speeds, as is sometimes necessary, is by no means as serious as may appear, and is not comparable to the many advantages possessed by alternating current.

The comparative advantages of a direct steam driven and an electrically driven plant is a question which the scope of this article hardly covers, but the possibility of increasing the number of sluicing units would make electric power even more attractive than it already is. The ability to quickly and cheaply install additional water or gravel pumps at necessary points, and the convenience of motor drives in the fitting shop, tin-dressing shed, etc., have obvious advantages, which are of very great value.

It is interesting to compare fuel costs at Cock's Pioneer and Y. Water and to contrast the conditions. These figures are given herewith.

	Cock's Pioneer	Y. Water
Depth of ground ...	78 ft.	35 ft.
Total height material is elevated taking out first paddock	140 ft.	120 ft.
Engines..................	Triple expansion Vertical High Speed Belliss-Morcom	Compound Vertical High speed, Belliss-Morcom
Average cost per cord of fire-wood delivered at boilers	16s. 6d.	15s. 6d.
Fuel cost per cubic yard	2·36d.	3·0d.

At the same time it must be remembered that the capital cost of an electrically driven plant will largely exceed that of a steam plant, so that on a property of limited extent, or where the work appears to be fairly free from complications, the additional outlay would not be justified. Where hydro-electric power is available, the question can be considered on its merits.

The connections between the engines or motors and the pumps vary with circumstances. With portable engines belts are almost always used, usually Balata. The older type of pontoon plant was almost always equipped with rope drives, the ropes being either $1\frac{3}{4}$ or $1\frac{1}{2}$ inches diameter. This was cheap in first cost, but uneconomical in running, as the conditions did not permit the use of pulleys of diameter to suit the ropes and so they did not last long. Ropes of 1 in. and $1\frac{1}{4}$ in. diameter on pulleys not smaller than 25 times the rope diameter are satisfactory, and if the ratio can be kept up to 30, so much the better. If the speeds are suitable direct connection by means of a sturdy design of flexible coupling leaves nothing to be desired.

On the new Y. Water plant there are two 14 in. gravel pumps, and one three-stage centrifugal nozzle pump direct coupled to three high-speed engines. Particulars are given herewith of the horse-power and revolutions per minute.

	Maximum B.H.P.	Maximum R.P.M.
No. 1 Gravel Pump Engine	280	430
No. 2 ,, ,, ,, ...	365	375
Nozzle Pump Engine	365	375

The engine speeds suit the gravel pumps, but if a higher speed had been possible it would have lowered the cost of the nozzle pump by reducing the number of stages. With electric power it is not difficult to obtain motors of such speeds as to suit every requirement.

At Cock's Pioneer also there are two 14 in. gravel pumps and a nozzle pump. No. 1 gravel pump is direct connected to a 175 b.h.p. motor, the maximum speed under full load being 363 r.p.m. A new motor of 250 b.h.p. and same speed is about to be installed, as it has been found that this particular unit is the one most frequently running up to its full rated capacity. No. 2 gravel pump which elevates the tailing from the sluice-boxes to the dump is driven by a 330 b.h.p. motor, with a maximum speed of 580 r.p.m., a rope drive being provided on account of the fact that the height to which the pump elevates the tailing varies between very wide limits, thus calling for a large variation in pump speed. In equipping a similar plant I would, however, couple the motor direct to the pump in this case also, as the motor when running at low speed has such a small load that the comparative inefficiency is of no great importance, especially as this condition obtains for a small proportion of the total time, and no difficulty has been found in running the motors at low speeds and small loads. The nozzle pump is direct coupled to its motor, which works at 730 r.p.m., and 280 b.h.p. There are a number of small motors on the mine for pumping, running the fitting shop, turning the amalgamating barrel, and so on. They are all 415 volt slip ring induction machines, with short circuiting device, as it is possible to run them at full speed. It is advisable to carry a few spare motors, say a 5 h.p. and 10 h.p. 1,450 r.p.m., and a 20 h.p. 730 r.p.m.

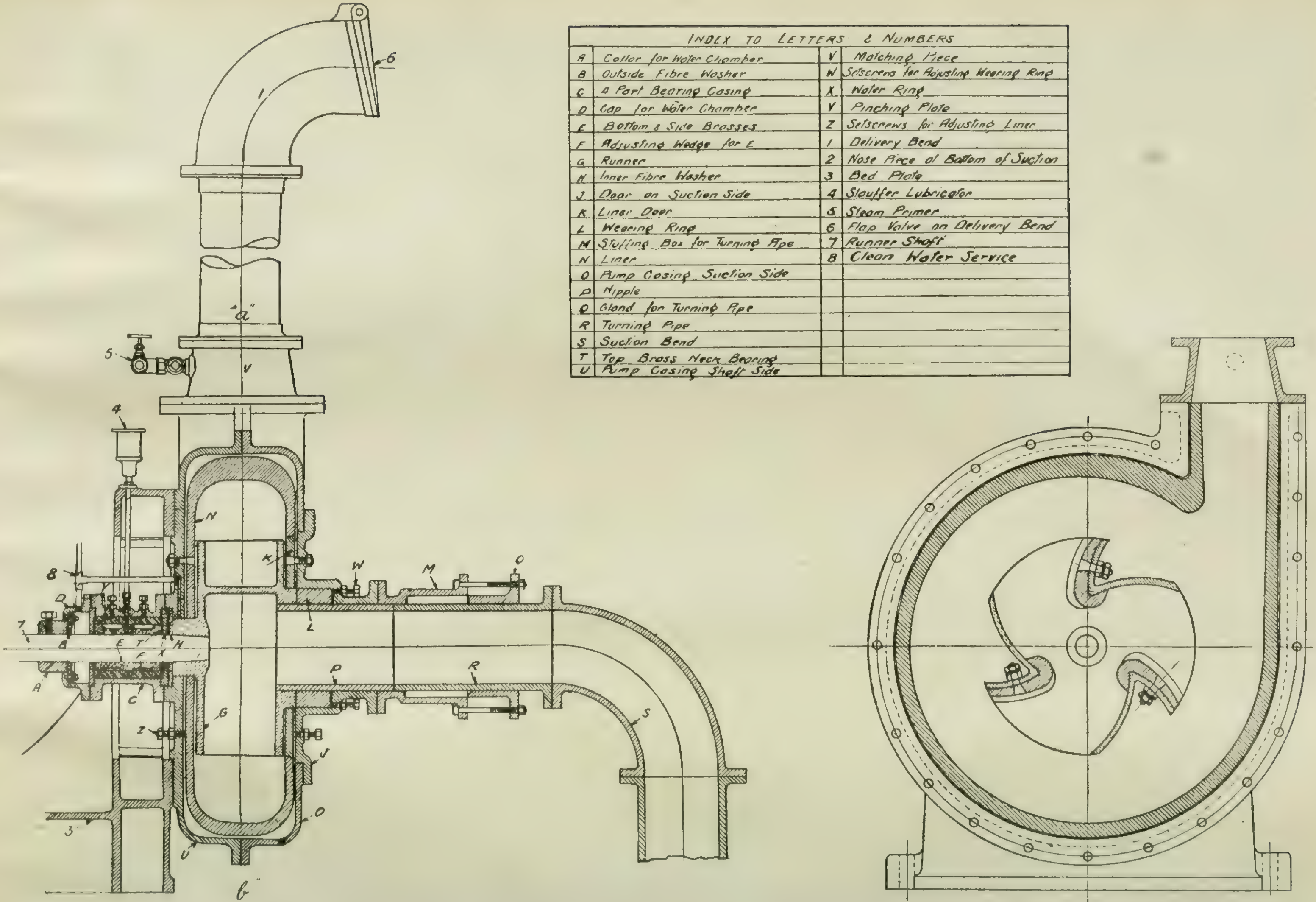
While taking out the first paddock the nozzle pump is not heavily loaded, for the water returning from the settling dam will be at about the level of the natural surface, and can therefore be led to the inlet side of the pump at a considerable pressure, depending upon the depth of the face. The gravel pump, or pumps if there are two, have a full load, as the whole of the material has to be lifted and dumped above surface level. In all subsequent paddocks, however, the loads on the pumps vary with the progress of operations. At the beginning, the nozzle pump has usually to lift its supply of water from a point some feet below its centre, and at the same time delivers it at a reasonable pressure, calling of course for a considerable amount of power. As the dam behind the plant rises, the water level in it also rises, until on completion of the paddock the nozzle pump has an initial head equal to the height of the natural surface above the pump centre less the pipe friction. In deep ground this may relieve the engine or motor of from 50 to 100 horse-power. The gravel pump on the other hand has an easy time at the start of a paddock, its load gradually increasing as the dump rises. When only one pump is in use and the boxes are situated on the bank, the load on the gravel pump does not vary much, as the suction is very soon deepened to the practical limit. When two gravel pumps are used, No. 1 has almost a uniform lift throughout, but No. 2 starts with a very small lift and finishes with a big one. The total power required is at its maximum toward the completion of a paddock, as at the beginning the total power may not be more than 75% of what would be required later. One point in favour of the system of using two gravel pumps is that full advantage can always be taken of this saving of power.

LIGHTING.—For working at night in safety and with efficient results it is essential that the paddock shall be well lighted. Arc lamps were once the standard form of lighting, but the half-watt lamps of high candle power either singly or in clusters are now being largely used. No other light but electric need be seriously considered for work of any importance, though many small sluicing properties have been worked at night by the use of other forms of outdoor lighting.

PONTOONS.—It is the almost universal practice to construct the pontoon of Oregon pine, the local hardwood not being suitable in several respects, though in certain localities an excellent hull could be built of this class of timber. The construction is usually very simple, being merely two or more tiers of beams at right angles to one another, with a solid wall of timber around the four sides. Vertical bolts about $1\frac{1}{4}$ to $1\frac{1}{2}$ in. diameter pass through all the points of intersection of the beams. About 18 in. of free-board should be provided after allowing for the weight of the hull itself, the machinery, and the housing. An external platform along one or more sides is very useful for the purpose of transporting pipes, valves, and other gear from one barge site to another. The superstructure is always a cheap timber framework, covered with corrugated iron, and provided with some heavy framework from which to hang lifting tackle and to carry some of the pipe columns. All joints are caulked with oakum, and the hull timber is given two coats of tar and pitch inside and out. It is usual to tar or oil the outside every summer, and a pontoon in a temperate climate should last 10 or 12 years. Effective ventilation below deck will help to preserve the timber.

The Cock's Pioneer pontoon is of the usual construction, 48 ft., by 35 ft. by 5 ft. 9 in. deep. The sides are 8 in. in thickness, the bottom 4 in., and the deck 3 in. The latter is caulked, which is a great improvement on the usual cheaper deck through the joints of which dirt can find its way, necessitating periodical cleanings, a most disagreeable job. The main timbers under the pumps are 20 in. by 10 in. Above No. 1 gravel pump a tower is carried up to a height of 50 ft. for convenience in supporting the delivery pipe, either for sluicing or while pumping out the paddock after floating. The old Y. Water plant with various additions measured 90 ft. by 45 ft., but the new plant although of 30% greater capacity is all carried with ample deck space on a pontoon 66 ft. by 60 ft., owing to the plant now being equipped with vertical high-speed engines. In some recently built pontoons substantial rolled steel joists have been used under the engines and pumps, by which means the pumps have been placed much lower, which is an advantage. Runways with crawls and chain blocks are provided above the gravel pumps for handling the liners and runners which require constant attention and frequent renewal.

GRAVEL PUMP.—The type in most general use has an impeller with three ports each capable of passing the same sized stone as the inlet and outlet pipes will carry. Full details of this pump are given in the accompanying drawings. This condition can but seldom be departed from for practical reasons and entails a low pump efficiency. Under the most favourable conditions the efficiency of a 14 in. pump will not exceed 50% while handling a reasonable proportion of dirt. In figuring on new work it is safer to assume a pump efficiency of about 40–45%, and with smaller pumps even these figures are too high. This class of pump runs best with a small depth of suction and against a total head of about 60 ft. As far as my experience goes the most favourable condition is for the pump to be self-priming, eliminating vacuum altogether on the suction side of the pump, but this of course is seldom practicable. Under this condition a 14 in. pump

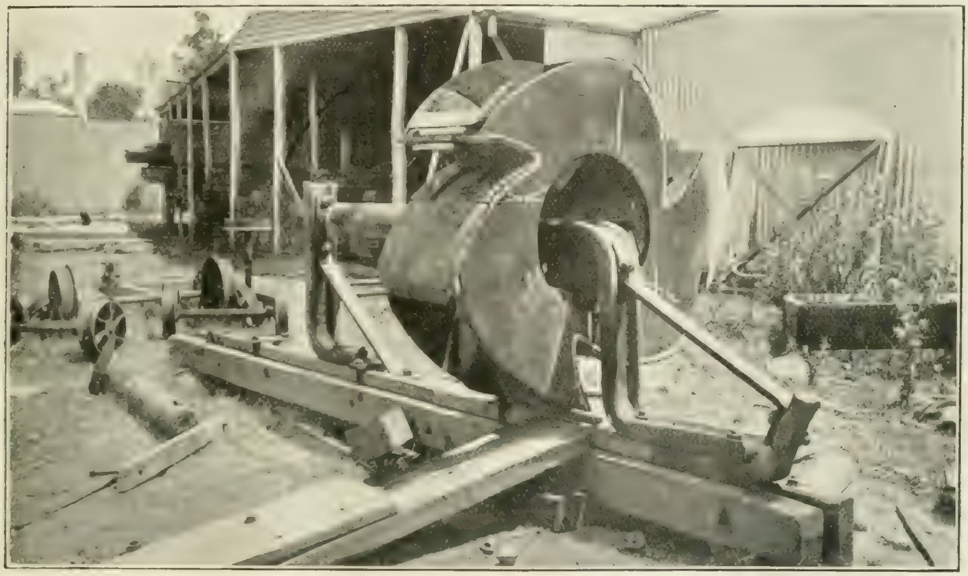


INDEX TO LETTERS & NUMBERS			
A	Collar for Water Chamber	V	Matching Piece
B	Outside Fibre Washer	W	Setscrews for Adjusting Wearing Ring
C	4 Part Bearing Casing	X	Water Ring
D	Cap for Water Chamber	Y	Pinching Plate
E	Bottom & Side Brasses	Z	Setscrews for Adjusting Liner
F	Adjusting Wedge for E	1	Delivery Bend
G	Runner	2	Nose Piece at Bottom of Suction
H	Inner Fibre Washer	3	Bed Plate
J	Door on Suction Side	4	Stauffer Lubricator
K	Liner Door	5	Steam Primer
L	Wearing Ring	6	Flap Valve on Delivery Bend
M	Stuffing Box for Turning Pipe	7	Runner Shaft
N	Liner	8	Clean Water Service
O	Pump Casing Suction Side		
P	Nipple		
Q	Gland for Turning Pipe		
R	Turning Pipe		
S	Suction Bend		
T	Top Brass Neck Bearing		
U	Pump Casing Shaft Side		

LONGITUDINAL AND CROSS SECTIONS OF THOMPSON'S GRAVEL PUMP.

has lifted 4,000 gallons of water together with 1·67 cubic yards of dirt per minute a vertical height of 113 ft. through 380 ft. of 14 in. diameter pipe. The pump efficiency was nearly 50%, but the wear on liners and impellers was heavy. Up to a total lift of 50 or 60 ft., wear is comparatively light, but increases rapidly after that. The liners are usually of cast iron, as it has been found that the extra life of cast steel is not sufficient to justify the increased cost. The impellers are usually of crucible cast steel and are provided with steel shoes to take the worst of the wear. The metal in the liner for a 14 in. pump is 2 in. thick, and on an average mixture of gravel, sand, clay, and loam the life of such a liner may be from 5,000 hours when working against a 40 ft. lift to 800 hours against a 120 ft. lift. The steel in the impeller varies from $\frac{3}{4}$ in. to $1\frac{1}{8}$ in. in thickness, and the life of an impeller is about one third longer than that of a liner running under similar conditions. Cast iron impellers can be used if there is no great quantity of heavy stone to deal with, but they should be made 30% heavier throughout.

Gravel pumps are made in the following sizes: 8 in., 10 in., 12 in., 14 in., 15 in., and 16 in. The 8 in. pump is not much more than a toy, and the 10 in. pumps are used only for small operations. The 14 in. is the more generally used of the larger sizes, and is capable of handling up to 150 yards per hour under favourable conditions. It is alleged that 250 cubic yards per hour can be dealt with by a 14 in. pump, but I cannot vouch for the accuracy of the figures. Over a long period an average of much more than 100 yards per hour for a 14 in. pump is good work, assuming that the material has to be elevated 60 or 70 ft. If the lift is small, say 20 to 30 ft., the output can be considerably increased because much more water can be handled. A 10 in. pump can deal with 100 cubic yards of solids per hour against 15 ft. head. I am not in a position to state the maximum height to which this class of pump will elevate a working mixture of water and dirt, but I know of two instances of high lifts which are worth quoting in case a specially high lift was contemplated. In the first instance a 14 in. pump with a 42 in. diameter impeller lifted 3,600 gallons of water per minute together with $1\frac{1}{2}$ yards of gravel through 200 ft. of pipe, the pump centre being 16 ft. above the pumphole and 84 ft. below the point of delivery. In the other, a similar pump with a $46\frac{1}{2}$ in. diameter impeller lifted $1\frac{1}{3}$ cubic yards of solids together with 4,000 gallons of water per minute a height of 113 ft. through 380 ft. of pipe, but in this case the material entered the pump just at atmospheric pressure. It is difficult to give a satisfactory rating of the duty of each size of pump, but an indication may be given of what a 14 in. pump should do. Assume that there is some ground to be worked consisting of a layer of about 6 ft. of gravel with 30 or 35 ft. of sand and loam above, so that the duty of water may be expected to be about 15.



RUNNER FOR 14 IN. GRAVEL PUMP.

We will furtherassume that the soakage water coming into the workings can be neglected, and that the height to which the material has to be elevated is 50 ft. above the pump centre. To this must be added say 6% of the length of pipe to provide for frictional loss, say 12 ft. The maximum vertical depth of suction up which an average mixture of dirt and water can be drawn is about 18 ft. at sea level, diminishing 1 ft. for each 1,000 ft. of elevation. Water containing small quantities of solid matter can be lifted from a depth of 25 or 26 ft. just as in the case of an ordinary water pump, but such depths are quite out of reach when any considerable proportion of solids are present. To come back to the instance before us, a 14 in. pump can comfortably handle 5,000 gallons per minute. This is equivalent to 800 cubic ft. per minute, or nearly 30 cubic yards per minute. With a duty of 15, the pump will therefore handle two cubic yards per minute, or 120 cubic yards per hour, of solid matter. With these quantities I should use a 14 in. diameter suction pipe, and a 15 or 16 in. delivery pipe, the former if there were any awkward bends, the latter if a good even slope could be arranged. The velocity in a 16 in. pipe carrying 5,000 gallons per minute is 9·5 ft. per second, which is just a little too slow unless conditions are favourable. The pipe velocity should be from 10 to 12 ft. per second to prevent sanding up the pipe.

If the bottom of the paddock is soft, races can be cheaply cut to lead the water from any required direction to the pumphole, but if the bottom is hard it is usual to extend the suction pipe a considerable distance toward the face to minimize the cost of race cutting. I have heard of a length of 300 ft. being used on the suction of a 14 in. pump with success, but from my own experience I can only speak of one 190 ft. in length. In using a suction pipe of any length it is absolutely necessary to avoid laying it horizontal. As much slope as possible should be allowed, 2 or 3% if practicable, rising toward the pump. Before using a line of newly laid suction pipes it is advisable to put a dead plate over the end and fill the pipes with water in order to test the joints. Some of the joints are certain to require attention, and the test will save hours or even days of unsatisfactory running caused by small undiscovered air leaks. The two cubic yards of solid matter which the pump is to lift will probably weigh about 6,000 lb., so that the total weight to be lifted is 56,000 lb. per minute. The height has been assumed at 50 ft., plus 12 ft. friction, plus 18 ft. suction, total 80 feet. The water horse-power therefore is 136. It would not be safe to assume more than 45% pump efficiency, so that 300 b.h.p. is required at the pump shaft. The power of the engine or motor could be fixed at 300 b.h.p., if direct coupled, and if the lift calculated were certain to be the maximum required, but the installation of a 350 b.h.p. engine or motor would be better practice. For the duty described I should use an impeller between 42 and 45 in. diameter. The required speed would be approximately

$$\text{R.P.M.} = \frac{60\ K\ \sqrt{H}}{P}$$

H being total head in feet.
P being periphery of impeller in feet.
K being a coefficient, having a value of 7·25 to 7·75 as a rule.

In the instance given, where the head is 80 ft., assuming $K = 7{\cdot}5$, the r.p.m. would be 366, so that an engine running at 375 r.p.m., one of the standard speeds, would suit the pump. Motors of suitable speed would be obtainable if the current were either 60 cycle or 40 cycle, but for 50 cycle current the nearest speeds would be 360, just too low, or 410, which might be rather high. The difficulty would be overcome by using an impeller about 43 in. diameter and a 360 r.p.m. motor.

The amount of clearance between the outside of the impeller and the inside of the liner is usually made large enough to avoid trouble when large stones or pieces of timber are passing through the pump, but if there is only a small quantity of such material, and especially in the few cases where it is absent, the clearance can be reduced with consequent improvement in pump efficiency and reduction in the weight of the liner.

There are several parts of a gravel pump subject to rapid wear, and if the plant is in an inaccessible locality an ample supply of spares should be kept on hand; at least one liner and say two doors for same, one or two impellers and spare shoes, an impeller shaft, and the inner portions of the turning gland which is provided on the suction side of the pump. Close attention should be given to the gear and tools required in connection with changing liners and impellers so as to avoid loss of running. A certain amount of lost time is unavoidable in sluicing, and a considerable portion of this is usually due to gravel pump troubles. On the shaft side of the pump is a water-sealed bearing, which must be kept in first class order to allow of good work being done. Experience will show how long this bearing can be allowed to go without examination and there should be a strict rule that this time must not be exceeded. Advantage can be taken of stoppages for other causes, or on Sundays, to examine and repair the gravel pumps. On the suction side of the pump is a turning gland to which the suction pipe is fixed; near the gland there is a bend say from 60 to 90°. The lower end of the pipe is carried by a wire rope tackle or chain blocks supported by shear legs or by a jib from the hull of the pontoon. The height of the pumphole can thus be regulated and the pipe raised and lowered as required.

NOZZLE PUMP.—A centrifugal pump having an efficiency of something over 70%, and capable of handling dirty water without excessive wear, is required for this work. If electric power is available, a motor running at from 700 to 1,000 r.p.m. allows of a single-stage double-section pump, which is to be preferred. If steam driven, the slower speed necessitates two or three stages and a more expensive pump, a type which is more difficult to dismantle for examination or repair.

SERVICE PUMP.—This is an important unit, and should be in duplicate to avoid loss of sluicing time. Its duty is to supply clean water under pressure to seal the shaft side of the gravel pump, and if the sluicing water is very dirty to keep the nozzle-pump glands in good condition. For a 14 in. gravel pump plant, 60 to 80 gallons of service water per minute would be required, and it should be supplied at a pressure of a few pounds per square inch higher than the pressure being developed by the gravel pump. A centrifugal service pump is preferable, as it gives a constant and not a pulsating pressure. The service pump should be independently driven, though in some cases it may be belt-driven off one of the larger units. The best system of all, if it is practicable, is to have a fresh water supply under natural head.

PIPING.—For the nozzle-pump delivery column, spiral rivetted mild steel pipe is the best. Flanged joints are provided as far as a certain point where there is a Y pipe with two and sometimes three branches. On each branch there must be a valve so that any one nozzle may be operated by itself. The pipes leading from the Y pipe to the nozzle had also better be spiral rivetted, but they should be in comparatively short lengths, say 15 ft., with telescope joints provided with two lugs and two heavy bolts. This style of joint allows the pipe to be led around easy curves and to follow an uneven bottom without much excavation, and the simple fastening provides for quick coupling and dismantling. For handling the dirt and water, whether on the suction or delivery side of the gravel pumps, the best class of pipe is lap-welded steel, the metal being $\frac{1}{4}$ to $\frac{1}{2}$ in. thick. The pipes should be about 15 or 16 ft. long, and plenty of short lengths provided. Bends are usually of cast iron, one inch thick, with faced flanges. The flanges on the lap-welded pipe should be made of 3 by 3 by $\frac{5}{8}$ in. angle iron, and with 8 or 12 bolts a good tight joint can be made with a gasket ring. Eight bolts $\frac{7}{8}$ in. diameter will do for 14 inch pipe. The pipe leading from the intake shaft in the settling dam and under the tailing to the nozzle pump is usually made of hardwood bevelled staves, rough sawn and not dressed. The staves are from 2 to $2\frac{1}{2}$ in. thick. Near to the plant, but at a point which will be ultimately well covered by the tailing dump, steel pipe is connected to the wood pipe and continued to the pump. Most of the steel pipe is subsequently recovered, but the whole of the wood pipe is lost. At Cock's Pioneer, owing to the great depth of the ground, reinforced concrete pipe was used, so far with satisfactory results.

The intake shaft is usually vertical, four or six 6 by 6 in. posts being erected first and well stayed to a broad base. The strainers or gratings are placed at either end of the shaft, or else there is a sloping grating on a frame over the top. An inclined shaft is being tried at Cock's Pioneer, with a set of screens carried on a movable frame, which is raised as the level of the slime and water rises. This shaft is of heavy construction, 7 by 7 in. timber well stayed and covered with 8 by $3\frac{1}{2}$ in. planks. This is costly, but the design was adopted on account of the excessive depth of the ground. A vertical shaft nearly 80 ft. high, though surrounded and held up by slime, seemed a rather risky structure.

COSTS.—The capital cost of a hydraulic sluicing plant is considerably more than that of a bucket-dredge of equal capacity. A 14 in. gravel pump plant, steam driven, would cost complete at pre-war prices at least £12,000, without allowing for preparatory work, dams, buildings, shops, etc. £25,000 would be little enough with which to properly equip a plant of this size capable of dealing with from 600,000 to 800,000 cubic yards per annum. Small plants to handle say 200,000 to 300,000 yards per annum driven by portable engines have been equipped before the war for as little as £5,000, or even less, but some of the equipment would probably be acquired second-hand. In deep ground a good deal of expense is incurred in getting the plant down to the bottom, as this has to be done in steps of about 15 ft.,

Details of Results at Cock's Pioneer.

Time worked 1,847 hours. Actual Sluicing Time 1,645 hours, equal to 89·06% of Full Time.

Yardage Treated, 178,000 Cubic Yards { 108·2 Cubic Yards per hour Actual Sluicing Time. / 96·3 ,, ,, ,, Full Time.

Area Sluiced...... 1·87 Acres. Duty of Water 15.

Gold Won......... 2,404·25 Oz. Gold Yield per Cubic Yard 12·966 pence.

Tin Won .... 32·5 Tons. Tin Yield per Cubic Yard 0·409 lb.

Working Cost.

Item	Wages	Stores	Fuel	Supervision	Total	Cost per Cu. Yd. Pence
Sluicing	£1,958 0 0	£162 12 10	£1,450 3 9	£342 5 6	£3,913 2 1	5·28
Repairs and Maintenance	347 12 11	424 2 4		95 12 6	867 7 9	1·17
Tin-Dressing and Amalgamating	90 19 10	12 1 2		16 5 0	119 6 0	0·16
Tin Realization	3 9 0	1 2 6		12 6	5 4 0	0·01
General Work	79 14 1	12 16 2	1 15 4	14 8 3	108 13 10	0·14
Office Expenses	5 9 0				5 9 0	0·01
	£2,485 4 10	£612 15 0	£1,451 19 1	£469 3 9	£5,019 2 8	6·77
Sundries:						
General & Travelling Expenses, Lease Rents, Insurance, etc					278 17 8	0·37
Provision for Costs Suspense Account					927 1 8	1·25
					£6,225 2 0	8·39

each one necessitating flooding the workings and floating. The first paddock opened up is rather costly owing to the fact that the whole of the tailing has to be elevated on to the natural surface, thus increasing the power consumption and also limiting the output of the plant. After getting the plant on to the bottom and completing the first paddock, the cost of treating average ground will probably be between 7d. and 9d. per cubic yard. These figures are based on a basic rate for labour of 9s. per day of eight hours and firewood at 14s. per cord of 128 cubic feet. The lower figure in my opinion represents the best attainable result under favourable conditions. In special cases, say where cheap hydro-electric power or water under natural head is available, lower costs are possible. Unfortunately a great deal of pump-dredging has been carried out without systematic record based upon accurate measurement of yardage. Statements to the effect that ground 40 or 50 ft. deep has been treated for 5d. per cubic yard must be regarded with grave doubt. I am of the opinion that the average cost of all the ground treated in Australia by this process is somewhere about 8d. per cubic yard, instead of about 6d. as is often stated, and most of this work was done with cheaper labour and fuel than is now obtainable. At Y. Water the average working cost over a period of three years was 10d. per yard, including the outlay involved in moving the plant, which was approximately ½d. per yard. The new plant has recently been put into operation, with the result that costs have been reduced to less than 8d. per cubic yard.

The cost at Cock's Pioneer of taking out the first paddock of 1,086,000 cubic yards was just under 9d. per yard, and this figure includes a provision of 1¼d. per yard placed to the credit of a suspense account to cover the cost of moving plant, creek diversion, and building dams and races. Since completing this paddock, costs have averaged 8½d. An examination of a number of cost sheets shows that wages and salaries make up half the total, fuel one third, and timber, pump spares, and general supplies, one sixth. A summary of a typical cost sheet is given herewith.

Costs, Running Time, and Output.—The cost of running a 14 in. plant is rather more than 1s. per minute. If the percentage of running time can be kept above 90, it represents fairly good work, and if 100 cubic yards of ground can be handled for every hour in the week, there is not a tremendous margin for improvement. The new plant at Y. Water has treated 130 yards per hour of actual sluicing for a run of several weeks, and should average more than 120 throughout. At Cock's Pioneer in very deep ground it is hoped to attain about the same output. Large plants should always be operated continuously for three shifts, though it is possible to run the small plants economically on two and sometimes even on one shift if circumstances prevent work from being carried on continuously.

For the drawings accompanying this paper, I am indebted to Messrs. Thompson & Co., of Castlemaine, Victoria, who have supplied a large number of plants of this type.

ORE TREATMENT AT THE PERSEVERANCE MINE,

KALGOORLIE, WEST AUSTRALIA.

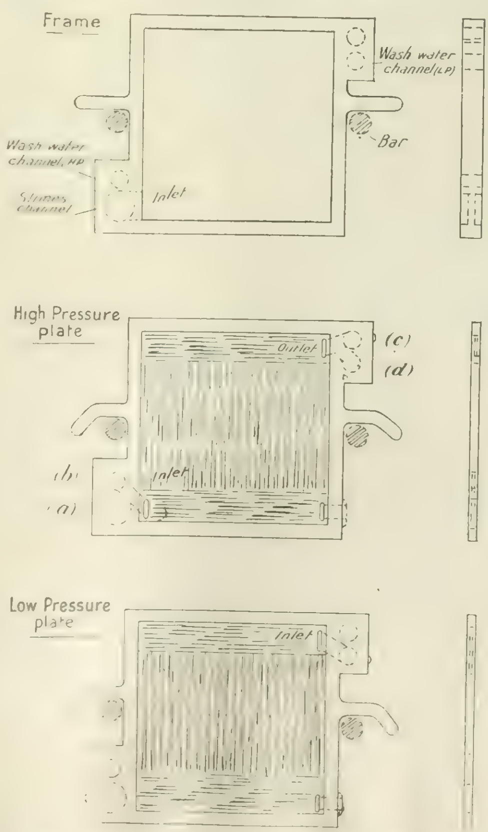
By the late W. R. CLOUTMAN, A.R.S.M.

(Continued from June issue, page 304).

The final instalment of this article describes filter-press practice, Dehne clarifiers, zinc-box practice, and methods of extracting metal from the precipitates.

Filter-Presses.—After agitation in the cyanide vats, the gold-bearing solution is separated from the pulp in Dehne filter-presses. The presses are filled from a sump into which the contents of the agitation vats are run as required. The sump has a capacity $1\frac{1}{2}$ times that of a vat, and it has an agitator to prevent sand from settling. The pulp is forced into the presses by two 3-throw pumps, requiring 20 to 25 h.p., with 9 in. plungers and 18 in. stroke. The pumps are kept constantly at work. When not pumping into presses, they pump the pulp back into the sump through a by-pass. Filling ordinarily takes 25 to 30 minutes. During the first fifteen minutes the rise in pressure is slow, reaching about 20 lb. per square inch; it then increases rapidly during the next five minutes up to 70 lb. The pressure is not allowed to rise above this level, owing to the risk of the presses bursting. Increase in pressure is prevented by gradually opening the cock of the by-pass opening back to the sump. The presses usually take about 4 minutes at 70 lb. pressure to fill completely. The main pipes from the vat are 8 in., and they have 4 in. branches to each press. The pulp channel is the lower left hand one (*a*) in the illustration. It passes, like the other channels, through all the frames and plates, and forms a continuous channel extending the length of the press. Only the frames are connected with it, so that pulp can only find its way into the cells bounded on either side by plates. At the far end of the pulp channel is a plug-cock, which can be removed in order to clean out the channel. This opening could also be used as an outlet, if sluicing the cakes out of their frames were feasible.

The press consists of 50 frames alternating with 50 plates, which are also alternately "high" and "low pressure" plates. The plates have corrugated surfaces to facilitate the passage of the solution behind the filter cloth. The high-pressure plates each have a groove connecting with the channel (*d*); the low-pressure plates connect with channels (*b*) and (*c*). All the plates also have grooves connecting with outside taps, to let out gold solutions when the presses are filling. These taps are not now used, owing to the ease with which they may get damaged, when emptying the presses. The frames and plates are supported by a bar on each side, and are screwed up together, preparatory to being filled. The tightening is done by wheels working on the screwed end of a central bar, and a capstan wheel operating levers, which force the plates together. When filling, the solution, forced from the pulp in the frames, finds its way through the cloths on to the plates, and out through channels (*b*), (*c*), and (*d*), which lead into the launder to the gold-sump. As this launder cannot carry the whole of the solution, a little is allowed to go through another branch from (*a*) leading to the sump from which the head tanks are fed. The channel (*c*) permits air to escape and acts as an indicator, as solution no longer flows from it when the press is full. When the press is full it is washed. It may be washed on either



Details of the Dehne Filter-Press.

the high or low-pressure sides. If from the former, wash-water enters through (*b*), passes through the cloth, pulp-cake, and cloth on the next low-pressure plate, and out through (*d*), the valve at the end of channel (*c*) being shut. If washing from the low-pressure side, the process is reversed.

The filter cloths have a life of one month, but are not all renewed at the same time. The high-pressure plate cloths are all put on together when the cloths on the low are a fortnight old, and another fortnight later the low cloths will be renewed. This scheme is adopted to secure better washing. The calcium sulphate in the solutions deposits on the cloths and makes them hard and impervious to solution. By renewing the high and low plate cloths at different times, all the cloths are prevented from being hard together. If all the cloths were hard, inferior filling, washing, and drying would result. The pulp-cakes are washed from the soft cloth side, and by this means a much greater bulk of wash solution can be forced through in a given time, than when washing from the hard cloth side.

The washing solution consists of zinc-box tails, that is, a weak cyanide solution carrying approximately 0·025% free cyanide. This solution runs from the zinc-boxes into a special sump (No. 4), 25 ft. diameter, 7 ft. 9 in. deep, and holding 23,600 gallons. The wash pump is an electric driven three-throw plunger pump of Aldridge type, 30 h.p., 250 gals. per min., 8 in. plungers, 6½ in. stroke. It can draw either from this sump or from a fresh-water tank. Fresh water must be regularly added to the circulating solutions to make up for the moisture (18%) left in the residue-cakes. The period of washing is never less than 15 minutes, and may be up to 30 minutes. The pressure is usually about 50 lb., but may vary from 40 to 70 lb. according to the number of presses being washed (4 to 6), and the state of hardness of the cloths. The wash water is sampled at each wash. It passes in a launder to No. 3 sump, from which it is pumped up to the head storage tanks. An overflow from the latter leads down to the pumps, indicating the state of the tanks. If No. 3 sump gets low, No. 3 pump can draw its water from the wash-water sump. After being washed, the cakes are dried by compressed air, sent in the opposite way to the wash water. The drying takes 7 minutes. The press is then unscrewed and the cakes are dropped by tilting the frames and pushing the cakes out. The cakes fall through a long chute under the press on to a conveyor belt beneath, which in turn drops the residues on to a cross belt. The residues are taken from the cross belt by another belt, and dropped through a metal chute into residue trucks underneath and carried away to the dump.

When emptying a press, slime adhering to the bottom of frames, or to the sides of frames or plates, is scraped off, so that, when tightening up, the press shall not leak. Beneath the filter cloth is a layer of Hessian which keeps the cloth away from the plate, and prevents it rusting and wearing into holes. The cloth and Hessian are tied in three places down the sides. Strips of baize or filter cloth are stuck on to the top and sides of the plates, and baize on the bottom sides, so that the frames and plates can be tightened up, and a tight joint made all round. Slime and solution leaking through is caught by traps beneath the presses, and run into a launder at the side. A press is dropped and screwed up again ready for filling in 10 to 20 minutes. The whole cycle takes about 70 minutes. There are 11 presses, of which one may be being re-clothed and the rest in use, two apiece among 5 pairs of pressmen. The tally for each pair is 9 presses per shift. Press plates in time become coated with calcium sulphate, like the cloths, and their channels and grooves block up. They are then taken out and sand-blasted. Two men can clean 8 plates in a shift. The cost of sand-blasting 50 plates, including sand and labour for removing and replacing the plates, is about 15s. 6d. A filter cloth is 7 ft. long, 3 ft. 4 in. wide, and weighs 3¼ lb. The cost of 50 cloths at 1s. 9d. per yard equals £10. 5s. The cost of 50 Hessian at 5d. each equals £1. 1s., and of 13 yards of baize at 3s. 5d. per yard equals £2. 4s., making a total cost for re-clothing a press throughout of £13. 10s.

The thickness of the pulp should be such that 2·5 to 2·7 presses go to one vat. If the pulp is thicker (3·0 presses and over) filling takes less time, but amalgam is scoured out of the pans by thick pulp and the extraction goes down. There are steam pumps which can be used instead of the electric ones, should any of the latter break down, also a spare wash pump, electrically driven. All the pumps have by-passes, by means of which high pressure can be relieved, and if a sump is low, the pump may be made to return its water through the by-pass, so that the pump does not lose its water as it would if it were stopped. The pulp-cakes are 3 in. in thickness. The capacity of each press is 5·15 tons. Automatic charts record the period and pressure during filling and washing.

DEHNE CLARIFIERS.—The gold solutions from the presses run into No. 1 gold sump, which acts as a settler, and has an overflow into No. 2 gold sump. These sumps are 25 ft. diameter by 5 ft. deep, and hold 15,200 gallons each. The clarifier pump is an electrically driven 3-throw Aldridge pump of 10 h.p. It draws in the ordinary way from No. 2 sump, but can also receive solution straight from No. 1 sump. This sump forces the gold solution through one of the clarifiers at 40 to 50 lb. pressure. There are two of these Dehne clarifying presses, each of which can deal with 1,200 tons of solution daily. They have 63 frames each, and form 2 in. cakes. They also differ from the other presses in that the cocks on the frames are in use, and the filtered solution finds its way through the cloths, out through the cocks, and into the launder at the side. These presses are used alternately, and are cleaned out once a fortnight. The launders take the clarified solution to 4 distributing boxes.

ZINC-BOXES.—There are 17 precipitation boxes, having outside measurements 20 ft. long, by 3 ft. 6 in. wide, by 3 ft. deep. They are of the ordinary type, built of wood, having 8, 9, or 10 compartments. The inside measurements of the compartments are 2 ft. 10½ in., by 1 ft. 4½ in., by 2 ft. 3 in. deep. The gap between the divisions of the compartments is 2½ in. wide, and the lower entrance to it is about 3 in. from the bottom, the bottom sloping from one side to the other with a fall of 1½ in. in its width. This slope facilitates the cleaning up of the slime on the bottom of the compartments. Some of the boxes also have a plug hole at the bottom of each compartment so that slime, etc., can be run out. These holes are not used, being liable to lead to leakage and loss of solution. On the top, adjoining partitions have a difference in level of 1¾ in. The box, as a whole, has a slope of about 3 in. in its length of 20 ft. The trays carrying the zinc shavings are of metal and have screens with 4 holes per inch. They rest on wood strips nailed to the sides of the compartment about 6 in. above the bottom. The cubic capacity of the compartment above the tray to the level of the overflow is 7·1 cubic feet. The solution enters from a pipe at the top of the 2½ in. gap at the head of the box, passes up through the first compartment, down between the partitions, up through the second compartment, and so on, finally leaving the box through a pipe leading into open launders, which take the spent solution to the wash-water sump.

THE RUNNING OF ZINC-BOXES.—It is usual to pack the first lot of compartments with zinc shavings and to leave the last two or three compartments empty in order to catch any slime carried over. The zinc in the boxes is packed loosely, care being taken to pack well at the sides, because if channelling occurs it is commonly there. Boxes tend to channel more readily when packed tightly. The solution is also prevented from passing through quickly. It has been found essential to run the boxes fast, if the precipitation of sulphate of lime on the zinc and on the sides of the boxes is to be prevented. Hence instead of the 17 boxes being in use, as formerly, only 10 are now being run. The zinc shaving has an average width of 0·024 in., and an average thickness of 0·004 in. Thus the surface presented per lb. of zinc works out at 21 sq. ft. The weight of zinc per compartment is about 37 lb. Hence assuming an average of 7 compartments filled per box, the total surface of zinc exposed is 5,439 sq. ft. The consumption of zinc per month averages about 3 tons.

The boxes are dressed every other day, and are cleaned up roughly once a week. At the weekly clean-up the rotten zinc on the top 2½ or 3 compartments is taken to the gold room, and after washing, the remaining zinc is returned to the top compartment. The shavings in the other compartments are all moved up, those from the 4th compartment going into the 2nd, and so on, while the bottom two or three compartments will receive new zinc. At the second of these weekly clean-ups, it is usual to clean out the slime on the bottom of the middle compartments. During the two or three dressings in the course of the week, the wastage in the top compartments is replaced from either the even or the odd compartments, leaving one or the other undisturbed, and replacing with new zinc in about two compartments; this applies to a 9-compartment box.

The tail solution from the zinc-boxes carries on an average 1·4 grains of gold per ton. If the precipitation goes off, it is usually due to bad roasts, with the consequent formation of sulphocyanide of potash, or to the deposition of sulphate of lime on the zinc. In the latter case, the only effective remedy is to take out all the zinc affected and roast it, replacing with new zinc. If due to foul solutions, precipitation may be restored by the addition of cyanide at the head of the boxes, as precipitation is usually better if the free cyanide is fairly high. If a drastic remedy is necessary, mercuric chloride is added to the head of the boxes. Lead acetate solution is always dripping into the tanks which distribute head solutions to the boxes. It is probable that the lead acetate in contact with the zinc instantly forms a zinc-lead couple, increasing the electromotive force of the zinc, and greatly improving the precipitation. From this source lead is introduced into the bullion, but the better precipitation offsets this disadvantage. A further advantage resulting from running the solutions fast through 10 boxes only lies in the fact that there is less zinc in use, and that the bulk to be washed and treated at clean-up time is much reduced. The use of lead acetate causes the gold to precipitate in a more slimy and easily detachable condition.

Consumption of zinc is 0·35 lb. per ton milled. At the monthly clean-up the first three or four compartments will be cleaned up and the contents washed, the washed zinc being returned to the top compartment, and filling about three quarters of it. At these monthly clean-ups, the gold-zinc sludge on the bottom of the top compartment is taken out. The exact procedure in cleaning-up zinc-boxes depends naturally upon the state of the zinc, and this again on the head values of the solutions sent to them during the month and other conditions affecting precipitaton.

Assuming 21 sq. ft. of zinc surface per lb.; 37 lb. per compartment; 7 compartments filled per box; 10 boxes; 700 tons ore milled per day; 2·2 : 1 as ratio of water to pulp; the total weight of zinc in boxes equals 2,590 lb., the tonnage of solution passed through the boxes is 1,540 tons, which less 18% moisture in residues is 1,260 tons. Hence, one ton of solution is treated per day by 2·06 lb. of zinc, equivalent to 43·3 sq. ft. of zinc surface. If the consumption of zinc be taken at 7,000 lb. per month and the cyanide bullion (900 fine) recovered at 5,000 oz., the consumption of zinc per oz. of bullion precipitated is 1·4 lb.

The rate of flow may be taken as 126 tons of solution per box per day, equivalent to 1 ton of solution issuing from each box in 11·6 minutes.

Calcium Sulphate in Zinc-Box Solution.—Calcium sulphate, though only slightly soluble, is liable to give rise to serious trouble in the zinc-boxes. If the boxes are run slowly, it precipitates on the zinc, preventing the precipitation of gold in the upper compartments. It is of course undesirable to have precipitation of the gold only in the lower compartment, as the effluent solutions are then likely to be carrying values. The calcium sulphate also precipitates as a crystalline deposit on the sides of the zinc-box partitions, and interferes with a flow of solution. If calcium sulphate precipitates on the zinc, the only remedy is to take the zinc out and replace it. Ordinary zinc shavings when taken out of the compartment begin to "steam" owing to rapid oxidation of the zinc, but if calcium sulphate be precipitated on them, they at once reveal the trouble by not steaming. By reducing the number of boxes in commission the solution can be run faster. Also by increasing the bulk of solution in circulation, the boxes may be run faster, and the precipitation of calcium sulphate reduced. The addition of lime to the solutions in the vats causes a marked decrease in the solubility of the calcium sulphate, and hence reduces its amount in the circulating solutions. The calcium sulphate is from time to time scraped off the sides of the boxes and treated for contained values. It is usually put through a No. 2 ball-mill, with no screens on, then into a separate Wheeler pan and run into a separate vat, where it is agitated with three or four successive quantities of cyanide solution, each lot being siphoned off in turn from the settled solution before addition of the next. The assay-value of the calcium sulphate usually runs about 33 oz. gold per ton, and by treatment as above the value of the residue in the vats is reduced to 2 dwt. gold per ton. The calcium sulphate is calcined in muffles before being passed through a pan to the cyanide vats.

Treatment of Gold Slime and Shorts.—The zinc from the top compartments is washed in a long bath. Small quantities are taken at a time, placed on a screen, and there vigorously shaken and turned over, to detach any adhering slime. This treatment of the zinc shavings results in the formation of a large quantity of small "shorts." The slime is washed out into a montejus, from which it is charged into a sludge press. This press has 22 plates, without frames, the cakes forming between the plates. Each of the plates has an opening to a lower channel, with a cock to each plate, and one to an upper channel, with a cock at the end. The feed is central. The cakes formed are about ½ in. thick. The plates are clothed with filter-press cloth next the plates, then swan down, and then a fine calico on the outside. The latter is periodically burnt and the ashes smelted to recover any gold in them. A plug can be screwed into the central feed channel so that a small quantity of slime can be confined to a few plates, if it is not desired to use the whole press. The slime in the press is dried by means of compressed air, then dumped on to a tray beneath the press, from which the slime is shovelled into small weighing trays, 4 ft. long by 2 ft. wide and 4 in. deep. The shorts are also washed and then transferred from the bath to similar small trays. The filled trays are then weighed separately. The solution from the press flows to the head tank sump. The pressure of air used in the montejus is 66 lb. per square inch.

ROASTING AND SMELTING OF PRECIPITATE.—The slime and the shorts are roasted in three muffles, each of which will hold two trays. Roasting volatilizes a large proportion of the zinc. All could be driven off if the precipitate were rabbled, but this would entail heavy dusting losses. The roasting of each charge occupies about 6 hours.

The difference between press and roasted weights shows that about 50% of the press weight of slime and of shorts is lost during the roasting process. The returns in October 1913 were:

	Press weights	Estimate of Bullion (740) Content
Zinc Shorts	501 lb.	3·5%
Gold Slime	309 lb.	14·2%
	Roasted weights	
Zinc Shorts	252 lb.	7·9%
Gold Slime	141 lb.	31·2%

The loss in weight must be largely due to moisture, as the pressed slime and the shorts are weighed wet.

The roasted gold slime and zinc shorts are treated separately in the first smelt. The resulting weights of bullion during October 1913 were from zinc shorts 20 lb., and from gold slime 44 lb. These two lots (15·3% on roasted weights) are then run down together. The "estimate of bullion content" given above is based on the weights from the first smelt, 20 lb. and 44 lb. respectively. These first smelts are now done in No. 156 pots, and the subsequent refining in No. 100 pots. These are required owing to the large bulk produced by granulating the gold. The first smelt takes 2 to 2½ hours. The charge is about 100 lb. of a mixture composed of 100 parts of roasted gold slime or zinc shorts, with 40 parts of sand and 40 parts of borax. A pinch of nitre is added during the smelt, and the fused mixture is stirred with an iron rod. When the reaction is finished, the pot is poured with the aid of tongs, which are hung by chains from an overhead crawl; the weight of the tongs and pot being taken by another man who holds a rope connected to the chains on the tongs over a pulley on the crawl. The man on the tongs fits them over the pot and does the guiding, and all the lifting is done by the man on the rope. The pot is poured into two conical moulds, a large one which gets the first part of the pour, and will only contain slag, and a small one, which will hold the gold button and a little slag. When slightly chilled, this small mould is tipped out, and the slag run off, and the matte scraped off the surface of the gold button, it being difficult to detach when cold.

When all the charges have been smelted, the resulting buttons are run down, and a dip sample is taken by means of a heated iron rod with a hole in its side near the end. The gold is granulated by pouring into a small tank full of water, the gold being caught in a bucket on the bottom. This bullion runs about 720 to 780 gold. In October 1913, the figures were 738·8 Au, 113·6 Ag, and 147·6 base. Until recently the gold from the first smelt was merely slightly refined with nitre, run into moulds, and shipped to England as about 750 bullion. The interest on the bullion during the time previously lost in transit is now saved by consigning the gold to the Perth mint. Penalties are charged if the bullion contains more than 25 parts base per 1,000, so that it is now refined on the mine.

Roasted gold slime and zinc shorts were smelted in large pots in tilting furnaces until October 1913. Afterward they were smelted separately, and either owing to the better smelt obtained, or to the separation of shorts from slime, the value of the slags was only 56 oz. per ton, as compared with 80 to 90 oz. and higher usually carried. The pots used are Morgan's graphite. Clay-lined pots have been used, and though they give a satisfactory smelt, the fusion is very slow.

REFINING WITH SULPHUR.—The granulated gold is mixed with ground sulphur, charged into a No. 100 pot, and run down, a rich matte being formed, and the grade of the gold being raised. The weekly clean-ups commonly result in the production of 60 to 70 lb. of bullion after the first smelt. This is mixed with 7 to 10 lb. of sulphur according to the appearance of the bullion, and the resulting bullion may weigh about 50 lb. The assay of bullion after the first sulphur, in October 1913, was 876·2 Au, 77·8 Ag, and 46 base metals. If the gold seems to need it, it will be given a second treatment with sulphur. The matte may carry 5,000 oz. gold per ton, and 5,000 to 6,000 oz. silver per ton. In fact the larger part of the silver in the bullion will enter the matte.

The following are characteristic assays of matte:

	Nov. 1912 oz. per ton	Oct. 1913 oz. per ton
Gold	4,824·8	5,743
Silver	6,548·8	5,639

REFINING MATTE BULLION.—The matte is treated by running down with iron two or three times, a smaller button of bullion resulting each time. This bullion is known as "matte bullion." With the matte is treated the slag from the fusion with MnO_2 in the last stage in refining, described later. In the first run-down, about 7 lb. of iron is added, and in the second about 4 lb. Enough iron is added in the third fusion to prevent it all being taken up. The matte remaining after the final fusion may carry 20 oz. gold per ton, and after being ground, it is mixed with the slags to be sent to England for treatment. In October 1913, the contents were 11·39 oz. gold and 1,507 oz. silver per ton. The matte bullion is refined by cupelling with its own weight of lead. The process is carried out in a special furnace, the bullion being cupelled on a saucer-shaped hearth. The hearth was made entirely of mabor in one instance, the resulting bullion only carrying 18 parts base per 1,000. In a second instance, a hearth half mabor and half cement was tried, the bullion assaying 61 parts base. An all-cement hearth was to be tested at the time of writing. The following assay figures relate to the results during August 1913:

	Au	Ag	Base
Matte bullion before cupellation	313·9	261·2	424·9
,, after ,,	518·9	419·4	61·7

The cupelled matte bullion is run down into a base bar, no further attempt being made to refine it. This bar carries most of the silver. Matte bullion could be refined by fusions with sulphur, but this would result in throwing back all the silver into the matte. The cupelled bullion should be removed as soon as it has sufficiently solidified. If allowed to grow cold undisturbed, it will adhere firmly to the hearth. The matte bullion after cupellation, during 1913, averaged 780 Au, 168·5 Ag, 49·5 base.

REFINING WITH MANGANESE DIOXIDE.—The bullion, after being refined once or twice with sulphur, is again granulated, mixed with manganese dioxide, MnO_2, and run down, the products being bullion 880 to 900 fine, manganese matte, and manganese slag. The two latter are re-treated with the matte from the sulphur refining. The weekly clean-up usually yields slightly less than 50 lb. of bullion after sulphur treatment. This is mixed with 5 lb. of MnO_2, and the resulting bullion may weigh about 11 lb. more than before treatment. After MnO_2 treatment, the bullion during October 1913 averaged 895·6 Au, 79·7 Ag, 24·7 base. Besides MnO_2, a little borax and sand is added as flux. The Mn slag and matte are returned to the pot while still hot, and the other mattes added for the matte bullion fusion. The refined gold is run down once more, and a little borax and bone ash are added. The latter collects impurities into a stiff slag mass easily removed with a skimmer. The gold is then poured into moulds as bars. These are numbered, cleaned in 50% nitric acid, 1 : 1 HNO_3, scrubbed with sand and a stiff brush, and finally weighed. The base in the bullion is mainly zinc, and also some lead. A characteristic assay of the manganese slag is: 61 oz. gold and 188·6 oz. silver per ton.

TREATMENT OF SLAGS FROM FIRST SMELT.—The slags from the first smelt are crushed with sand and borax in a No. 2 Krupp ball-mill with 30 mesh screens. The product is then agitated with mercury in an amalgamating barrel. The major portion of the gold in the slag exists as prills of free gold, which are liberated by crushing the slag. Seven bags (about 500 lb.) are put in a barrel with water, flint balls, and 20 lb. of mercury. The barrel revolves continuously for 2 or 3 days, when a fresh charge will be put in and if the mercury has become thick, more of it is also added. In all, about 100 lb. of mercury is put into each barrel per month. When emptying the barrel the solution is first run off and emptied into a tank. The barrels are then opened and cleaned, and at the end of the month the mercury is all drawn off and the barrel cleaned up. From the tank into which water and slime have been passed, the contents are passed through a mixer, which catches any fine mercury; they then flow into a settling tank, with an overflow to a second settler, and then in turn to a third. The clear solution from the third tank is pumped back to the mixer. The settled slag slime is dug out, dried, bagged, sampled, and shipped to England. The contents of the slags before amalgamation are 80 oz. gold per ton, and after 10 to 12 oz. gold per ton. The assay of slag bullion averaged 677·6 Au, 175·6 Ag, and 146·8 base.

TREATMENT OF AMALGAM FROM PANS.—The mercury obtained from the monthly clean-up of the pans is cleaned by agitating with short iron rollers in an amalgamating barrel for about 2 hours, water also being run in. At the end of this time, the water is run out into the settler, and the mercury into a bucket, in which it is further cleaned by sponging off slimy water and gathering the iron grindings which form in the barrel. The last of the grindings are extracted with a magnet. The mercury is then squeezed through a double thickness of fine calico, over a bucket of water. The squeezed amalgam carries 33% gold, and on retorting, this yields bullion about 940 fine. The gold obtained from the pan amalgam accounts for about 20% of the total bullion return. About two thirds of the mercury in the amalgam collected from the pans can be squeezed out.

SPECIAL CORRESPONDENCE

WESTERN AUSTRALIA.

The Mining Conference.—Some months ago, on his assumption of office as Minister for Mines, Mr. R. T. Robinson expressed a desire to meet the representatives of the mine owners and prospectors in order to obtain their views on the question of improving the mining industry of this State. Delegates from the Chamber of Mines and the various Leaseholders' and Prospectors' Associations were invited to attend a conference to be held at Kalgoorlie at the end of April, and the results of the discussions and suggestions should be of great assistance to the Government, and ultimately to the State as a whole

The Minister for Mines, in his opening address, gave some interesting facts and figures, which show not only what Western Australia has produced in mineral wealth, but also the great possibilities which may reasonably be expected, when, with the end of the war, our boys return and bring back with them to Sunny Australia fellow fighters who will be anxious to get out to the land where, in that free life of the prospector or farmer, they will have a chance of "striking it rich," or of securing a little bit of land and a home of their own. The Mines Department has already given valuable assistance to the mineral industry by the erection of State batteries for gold and tin, and a smelter for copper, by grants for lead smelting, and advances on other ores pending their sale in the Eastern States and England, together with financial assistance and the use of camels and equipment to prospectors. The Minister for Mines received a number of suggestions from the delegates which should increase the scope and value of development. The Government will no doubt give serious consideration to the increase of grants to enable new country to be prospected, mineral deposits opened up, and greater facilities for the treatment of gold and base metal ores. The suggestions made by the delegates in a conference extending over five days, also the papers prepared by several members, have been reported in full, and doubtless these will be published in a bulletin. It will therefore be sufficient to deal in this letter with the most important of these.

It was suggested that additional protection be granted to prospectors, that the fees payable by them in the matter of exemption, rents, and survey should be nominal until payable ore be found. The practice which has grown up during recent years at new finds, of speculators pegging out numerous leases for re-sale and flotation, and not doing any prospecting work until forced to do so by the Mining Act, is one that has been roundly condemned by the genuine prospector and those who find money for prospecting and developing mines. To obviate this trouble it has been suggested that only prospecting areas of 24 acres, instead of leases, be granted for some time after the discovery of a new field, and that each area be manned and prospecting operations commenced within fourteen days after it has been applied for. Such a measure would ensure a new field being prospected quickly, and would meet with general approval, provided that the original prospector be allowed to secure a reward lease not carrying labour conditions, while he held and worked a prospecting area adjoining it.

It was suggested by one of the Prospectors' Associations that an amount equivalent to 2½% of the dividends declared by each mining company operating in the State be devoted to prospecting new mining areas within the State. In a paper read by a member of the Conference, who is a big leaseholder, it was suggested that 5% of the profits from a mine be held in trust by the Mines Department, the said sum to be available to the mine owner when all of his capital has been expended, for the purpose of either purchasing or assisting to purchase a new mine in Western Australia, or to be spent in development in his own property or in prospecting for a new property. These two suggestions, although appearing at first sight as a further tax on mining, are really meant to assist in the perpetuation of mines in this State by those who have made profits therein.

In the past, the majority of companies have set apart a reserve fund from their profits, for the purpose of carrying out prospecting and development work after the mine had ceased to show profits, or to expend it in looking for, developing, and purchasing another mine to take the place of the original property when the latter was worked out. In many instances the companies have attained success in this; others, seeing greener fields in distant lands, have transferred a portion of their reserve to purchasing prospecting properties outside of Australia, with varying results. The Conference fully appreciated what has already been done, but the opinions generally expressed were that provision should be made by owners, whether companies or private individuals, in order that a certain proportion of the profits should be set apart for prospecting. The mining companies as such, have, with a few exceptions, not expended very much money in the past in this direction, although the individual shareholders have formed development companies, and the members of the staffs, as well as many employees, have personally expended a considerable sum per annum in prospecting.

There were many suggestions under the heading of prospecting to the effect that those making profits should expend a portion of such profits in prospecting in the State, that the Mines Department should make regulations to further encourage and protect prospectors, and that the prospector, in his turn, should give better service than he has in the past to his financial supporters.

The question of giving our returned soldiers opportunities to go out prospecting was one which was generally supported. The work is not hard, the free outdoor healthy life and the fascination of the possibility in striking a patch of gold which is felt by every mining man, are such that it must appeal to many of our men whose health and nerves would not allow them to live in the cramped and colourless existence of city life.

Suggestions were made that the plans and reports of the Geological Survey should be written more on the economic side, in language that could be understood and followed by the prospector and layman. It was specially desired that after a geological survey had been made of any district, the geologist who had carried out the work should lecture, and describe his plans and deductions to the miners and prospectors working in that centre.

It was suggested that the Mines Department should make arrangements to systematically test and sample abandoned mines from which gold has been recovered in the past, and that records of such mines be kept and be available at the nearest Mining Registrar's office. The Minister said that the Department was collecting information regarding abandoned mines, and steps would be taken to bring under the public notice shows which appeared to be worthy of further trial.

In the opinion of the writer, it would be advisable for the Mines Department to have mines sampled and records kept while the mine was working, so that, if it were abandoned at or below water level, anyone interested could inspect such assay plan in the Mines Department, and decide whether, under the conditions then prevailing, the property was worth unwatering and further development. Had such a system been in vogue, many thousands of pounds would have been saved in unwatering mines to see whether current reports as to shoots of ore were correct or not. Again, many small mines which have been stoped out to water level and abandoned because the owners had not the capital to sink deeper, might with advantage be worked again, but the cost of getting down to sample the bottom is too great to warrant the expense in view of the gamble involved.

It was decided that a similar Conference should be held next year, and the delegates were unanimously of opinion that in the present Minister for Mines investors and prospectors will receive sympathetic consideration of any scheme for the improvement of the mineral industry which has in the past done much, will in the future do more, for the advancement of the State of Western Australia.

C. M. HARRIS.

DISCUSSION

The East Pool Mine.

The Editor:

Sir—The very able article by Dr. Maclaren upon the geology of the East Pool mine contains a sympathetic reference to the opinion strongly held and constantly expressed by my late father in regard to the great probability of cutting a valuable lode by means of long cross-cuts to the north; that lode he believed to be the Great Lode heaved up by the New North Lode. In the spring of 1909 I made at his request an independent examination of the mine and was led to concur in his view, which indeed upon the evidence then available appeared to be the only view possible to anyone with any pretensions to experience in mining geology.

Dr. Maclaren now brings evidence to show that the Rogers Lode is not the Great Lode thrown up to the north, but a downward continuation of the north-dipping North and Dobree Lodes, basing his opinion upon the following facts:

(1) That the south-dipping New North Lode was not cut in the 160 fm. cross-cut.

(2) That the granite "on this side of the mine" is "nowhere upthrown to the north."

The first of these two arguments is I think somewhat weak. The 160 fm. cross-cut may have cut the Rogers Lode (as indeed the small amount of mineralization may perhaps indicate) immediately below the point at which the New North Lode fissure cuts it off, in which case the broken ground may possibly have obscured the fissure. Most of us can quote cases in which a considerable fault is found to be quite insignificant in width and almost unrecognizable at certain parts of its course. The second argument would be of great potency if entirely authenticated; I much doubt, however, if the work done "on this side of the mine" is as yet sufficient to justify the statement that the granite is "nowhere upthrown to the north." I hold therefore that my late father's interpretation of the facts, namely, that the Rogers Lode is in reality the Great Lode thrown up to the north, is by no means conclusively proved incorrect. Personally I shall continue to hold this view until further work to the hanging-wall side of the new Rogers Lode definitely proves that the granite is indeed "nowhere upthrown to the north," that is, upon the north side of the Rogers Lode, and until the Great Lode itself is actually cut, as Dr. Maclaren hopes that it will be, namely, between the New North and the Rogers Lodes in some of the deeper cross-cuts north below that at the 240 fm. level.

With another statement of Dr. Maclaren's I entirely agree, namely, that the upper parts of the tin-copper lodes, long since denuded away, were probably rich in tin and zinc. The view that lead and zinc in most of the Cornish lead lodes in killas could be replaced at greater depth by copper and still deeper by tin was I believe first advanced by my late father. Certainly it was long held by him and stated in several of his published writings prior to the appearance of his "Observations," in which it finds a prominent place.

HENRY F. COLLINS.

Cornwall, June 11.

PERSONAL.

GILMOUR E. BROWN has returned to Shanghai from Sumatra.

ARTHUR A. COLE, president of the Canadian Mining Institute, is visiting in turn the provinces of Alberta, Saskatchewan, Manitoba, New Brunswick, and Nova Scotia, for the purpose of organizing the collection of statistics for the Canadian Advisory Council of Research.

T. R. HAMBER, of the mining department of the Niger Company, has left on his return to Nigeria.

FRED. HELLMANN has left the United States for Chile to visit the Chuquicamata copper property. He expects to return in September.

FRANK E. LATHE, lately at the Granby smelter, British Columbia, has joined the metallurgical staff at Chuquicamata, Chile.

BERNARD MACDONALD has left the United States for South America.

B. H. MCLEOD has returned from Mexico and has joined the Flying Corps.

DAVID MEREDITH has been appointed manager for the Amalgamated Zinc (De Bavay's) company in succession to H. W. Gepp, who is now manager for the Electrolytic Zinc Company of Australasia.

MAJOR PETER N. NISSEN has been promoted to the rank of Lieutenant Colonel and is Commanding Officer of the Royal Engineers at General Head-Quarters, France.

B. TREVOR PHILLIPS is here from Celebes, Dutch East Indies.

THOMAS H. PRISK has been appointed manager for the Easter Iron Ore Mines Limited, Forest of Dean.

ARTHUR J. RUSSELL, managing director of the Tolima Mining Company, has returned from Colombia.

F. S. SCHIMERKA has been appointed research engineer for the milling department of the Arizona Copper Company.

ARCHIBALD STARK left on June 30 for Mexico.

F. L. TERRELL has left for Nigeria.

M. J. TURNER, underground manager of the Brakpan mine, is the acting general manager during the absence of C. R. Davis on leave.

VALERIUS, MCNUTT, & HUGHES have opened a branch office at Lexington, Kentucky, which will be in charge of Mr. McNutt.

J. T. WARNE left for the Ashanti mine, West Africa, on June 13.

DAVID WILKINSON, consulting engineer to the Neumann group, is joining the technical staff of the Transvaal Chamber of Mines.

H. G. YOUNG is now at the Valcartier Training Depot, Quebec, with the Canadian Engineers.

METAL MARKETS

COPPER.—No transactions are recorded on the London market. Official prices are fixed as follows: Cash standard, £130 to £130. 10s.; three months ditto, £120. 10s. to £130; electrolytic, £142 to £138; best selected, £140 to £136. The American market shows little fluctuation, the tendency on the whole being a declining one. Production is of course unparalleled. On the other hand, consumption appears easily capable of taking care of all the metal put on the market. Apprehensions have been expressed as to possible steps being taken by the United States government in relation to the fixing of prices, but these have not materialized, and buyers show a return of confidence. Consumers nevertheless are displaying caution in their purchases. The premium ruling for spot metal is becoming narrower, although supplies are somewhat limited. The market continues to be influenced by the offerings of second-hand parcels. The latest quotations for electrolytic spot are 32 cents, forward 29 cents, f.o.b. New York.

Average prices of cash standard copper: June 1917, £130. 5s. 0d.; May 1917, £130. 5s. 0d.; June 1916, £112. 17s. 9d.

TIN.—The downward course of the market brought the price of standard down to £235 for cash. At this level a recovery set in, and the closing values for June were £243. 15s. to £244 for cash, and £238. 10s. to £239 for three months. Prices are sensitive, no doubt on account of the scarcity of nearby material, and to the fact that owing to the action of the Admiralty cargoes are being discharged at Liverpool instead of London. Extraordinary delays are also being experienced in the arrivals of steamers carrying tin, and until these stocks are available the scarcity may become acute. Only moderate exports are expected from the East, and the indications are for a higher market again. Business with America has become restricted, although prices ruling there are much in excess of English parity. Arrivals have been large, and the stocks are considerable. Some very low prices are reported from the East, but latest prices are about the London equivalent. Batavia is reported quiet.

It has been agreed, we are informed, to quote English tin net in future instead of less 2½%.

Average prices of cash standard tin: June 1917, £242. 7s. 7d.; May 1917, £245. 2s. 10d.; June 1916, £179. 11s. 3d,

LEAD.—Material in this country is scarce, and all contracts are a good deal in arrear. The price is officially quoted at £30. 10s.–£29. 10s. In America prices are reported firmer, and far above English parity.

Average prices of soft foreign lead: June 1917, £30; May 1917, £30; June 1916, £30. 14s. 0d.

SPELTER.—The price of spelter is steady at £54 to £50. Demand is light. In America the feeling is easier and little business is recorded.

Average price of good ordinary brands: June 1917, £52; May 1917, £52; June 1916, £63. 16s. 4d.

NICKEL.—£225 per ton; in the United States 50 to 55 cents per lb.; 5 c. extra for electrolytically refined.

COBALT.—10s. per lb. A cobalt-chromium tool-steel is now being put on the market in Sheffield, particulars of which are given under Recent Patents.

PLATINUM.—Sold at 290s. per oz.; scrap bought at 260s. per oz. In the United States, $105 per oz.

QUICKSILVER.—£20 to £25 per flask of 75lb. In the United States, $85 per flask.

BISMUTH.—11s. per lb. CADMIUM.—7s. 6d. per lb.

TUNGSTEN.—Wolfram ores, 65% WO_3, 55s. per unit; tungsten powder 6s. 3d. per lb.; tungsten steel, 14% tungsten, 2s. 10d. per lb., 18% tungsten, 3s. 10d. per lb.

CHROMIUM.—Ferro-chrome, 4 to 10% carbon, £70 to £75 per ton; no quotation for chrome ores.

MOLYBDENUM.—Molybdenite, 90% MoS_2, 105s. per unit; ferro-molybdenum 16s. per lb.

ANTIMONY.—No quotation. In the United States, 20 cents per lb.

ALUMINIUM.—No quotation. In the United States 60 cents per lb.

MANGANESE.—No quotation for manganese ores. The supply to the United States is now greater, the shipments from Brazil having increased; the quotation there is $1·00 per unit on the basis of 49%.

SILVER.—The market is very sensitive owing to supplies being limited, and the price has gradually advanced to 39¾d. per standard ounces.

PRICES OF CHEMICALS. July 10.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d
Alum	per ton	15	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	32	0	0
,, Chloride of, grey	per cwt.	1	18	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	72	0	0
,, Phosphate of	,,	95	0	0
,, Sulphate of	,,	15	10	0
Arsenic, White	,,	85	0	0
Bleaching Powder, 35% Cl.	,,	26	0	0
Borax	,,	37	0	0
Copper, Sulphate of	,,	63	0	0
Cyanide of Potassium, 98%	per lb		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		11	4
Iron, Sulphate of	per ton	5	0	0
Lead, Acetate of, white	,,	95	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	46	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	11	0	0
Phosphoric Acid	per lb.			10
Potassium Carbonate	per ton	115	0	0
,, Chlorate	per lb.		2	6
,, Chloride 80%	per ton	60	0	0
,, Hydrate, (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	70	0	0
,, Permanganate	per lb		14	6
,, Prussiate, Yellow	,,		3	6
,, Sulphate, 90%	per ton	65	0	0
Sodium Metal	per lb		1	9
,, Acetate	per ton	85	0	0
,, Bicarbonate	,,	7	5	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	15	0
,, Hydrate, 76%	,,	24	10	0
,, Hyposulphite	,,	18	10	0
,, Nitrate, 95%	,,	24	10	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	7	0	0
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	24	0	0
Sulphur, Roll	,,	21	0	0
,, Flowers	,,	23	0	0
Sulphuric Acid, non-arsenical 140°T.	,,	4	5	0
,, non-arsenical 95%	,,	7	0	0
Superphosphate of Lime, 18%	,,	5	10	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
July, 1916	733,485	27,602	761,487	3,232,891
August	752,940	28,210	781,150	3,318,116
September	744,881	26,686	771,567	3,277,408
October	764,489	27,850	792,339	3,365,642
November	756,370	26,696	783,066	3,326,253
December	748,491	25,971	774,462	3,289,705
Year 1916	8,971,359	324,179	9,295,538	39,484,934
January 1917	756,997	25,637	782,634	3,324,418
February	696,955	24,366	721,321	3,063,976
March	760,598	26,496	787,094	3,343,363
April	717,598	25,180	742,778	3,155,121
May	753,531	26,034	779,385	3,310,618

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March 31	203,575	9,588	917	214,080
April 30	199,936	9,827	938	210,701
May 31	194,765	9,811	1,459	206,035
June 30	192,809	9,859	2,105	204,773
July 31	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500
October 31	199,330	10,907	6,358	216,595
November 30	196,132	11,118	5,928	213,178
December 31	191,547	11,487	5,194	208,228
January 31, 1917	188,624	11,611	5,591	205,826
February 28	191,095	11,568	6,268	208,931
March 31	190,028	11,494	6,620	208,142
April 30	185,975	11,435	6,314	203,724
May 31	180,168	11,432	5,805	197,405

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
July 1916	2,370,244	26 1	17 10	8 0	949,606
August	2,423,669	26 3	17 10	8 1	976,125
September	2,367,793	26 6	18 0	8 3	972,704
October	2,453,437	26 4	17 10	8 2	1,001,843
November	2,389,056	26 9	18 2	8 2	980,387
December	2,349,191	26 10	18 2	8 4	977,481
January 1917	2,337,066	26 10	18 8	7 11	941,520
February	2,153,691	27 3	19 2	7 10	841,259
March	2,430,590	26 7	19 0	7 4	879,351
April	2,235,833	27 2	19 2	7 8	857,710

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1916	1917	1916	1917
	£	£	£	£
January	318,586	296,113	140,579	131,665
February	313,769	289,734	137,739	104,892
March	335,368	300,183	150,987	158,727
April	339,386	297,977	135,976	123,825
May	323,783	299,271	132,976	121,104
June	333,070	...	127,107	...
July	322,365	...	128,574	...
August	338,001	...	125,143	...
September	322,035	...	127,138	...
October	325,608	...	132,577	...
November	317,135	...	130,101	...
December	306,205	...	146,409	...
Total	3,895,311	1,482,278	1,615,306	640,213

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
July, 1916	912	91,725	92,637	393,495
August	*	89,522	*	*
September	*	85,978	*	*
October	*	82,732	*	*
November	*	87,322	*	*
December	*	88,205	*	*
January 1917	*	83,962	*	*
February	*	81,810	*	*
March	*	76,171	*	*
April	*	82,144	*	*
May	*	78,165	*	*
June	*	82,600	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1916	1917	1916	1917	1916	1917
	£	£	£	£	£	£
January	89,900	67,627	66,700	50,150	39,000	29,000
February	76,500	65,450	79,050	63,200	30,000	26,000
March	103,600	74,794	76,920	61,200	36,000	41,000
April	60,000	...	83,300	62,470	63,000	21,000
May	119,500	...	116,230	65,450	19,000	...
June	86,000	...	72,200	...	18,000	...
July	100,600	...	85,400	...	23,000	...
August	66,800	...	86,000	...	24,000	...
September	115,100	...	65,450	...	32,000	...
October	81,400	...	74,800	...	32,000	...
November	94,000	...	60,300	...	31,000	...
December	96,600	...	73,550	...	111,000	...
Total	1,090,000	207,790	940,500	302,420	459,000	116,000

Production of Gold in India.

	1914	1915	1916	1917
	£	£	£	£
January	193,140	201,255	192,150	190,047
February	185,508	195,970	183,264	180,904
March	191,853	194,350	186,475	189,618
April	189,197	196,747	192,208	185,835
May	193,031	199,786	193,604	184,874
June	192,224	197,447	192,469	...
July	195,137	197,056	191,404	...
August	196,560	197,984	192,784	...
September	195,843	195,952	192,330	...
October	198,191	195,531	191,502	...
November	197,699	192,714	192,298	...
December	211,911	204,590	205,164	...
Total	2,340,259	2,366,457	2,299,568	931,278

Daily London Metal Prices

Copper, Lead, *Zinc*, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper Standard	Copper Electrolytic	Copper Best Select'd	Soft For'n Lead		*Zinc*		Tin Standard			Silver
June	£	£	£	£	s.	£	s.	£	s.	d.	d.
11	130	142	140	30	10	54	0	236	10	0	$38\frac{3}{4}$
12	130	142	140	30	10	54	0	236	0	0	$39\frac{1}{16}$
13	130	142	140	30	10	54	0	236	10	0	$39\frac{1}{16}$
14	130	142	140	30	10	54	0	238	0	0	$39\frac{1}{16}$
15	130	142	140	30	10	54	0	240	15	0	$39\frac{1}{16}$
18	130	142	140	30	10	54	0	249	0	0	$39\frac{1}{2}$
19	130	142	140	30	10	54	0	249	0	0	$39\frac{1}{2}$
20	130	142	140	30	10	54	0	249	0	0	$39\frac{1}{2}$
21	130	142	140	30	10	54	0	248	15	0	$39\frac{5}{8}$
22	130	142	140	30	10	54	0	246	10	0	$39\frac{7}{8}$
25	130	142	140	30	10	54	0	242	15	0	$39\frac{7}{8}$
26	130	142	140	30	10	54	0	243	15	0	$39\frac{5}{8}$
27	130	142	140	30	10	54	0	245	10	0	$39\frac{3}{4}$
28	130	142	140	30	10	54	0	244	0	0	$39\frac{7}{8}$
29	130	142	140	30	10	54	0	243	15	0	$39\frac{1}{2}$
July											
2	130	142	140	30	10	54	0	243	5	0	—
3	130	142	140	30	10	54	0	242	15	0	$39\frac{1}{2}$
4	130	142	140	30	10	54	0	242	0	0	$39\frac{7}{8}$
5	130	142	140	30	10	54	0	245	0	0	$39\frac{7}{8}$
6	130	142	140	30	10	54	0	245	10	0	$39\frac{13}{16}$

IMPORTS OF ORES AND METALS INTO UNITED KINGDOM.

These figures do not include Government imports.

* Statistics not published. Long tons.

	Year 1916	April 1917	May 1917	Year 1917
	Tons	Tons	Tons	Tons
Iron Ore	6,905,936	522,289	*	*
Copper Ore	34,492	777	*	*
,, Matte and Precipitate	43,839	3,997	1,096	10,404
,, Metal	111,412	9,776	6,545	38,460
Copper and Iron Pyrite	951,206	84,928	*	*
Tin Concentrate	33,912	2,584	*	*
,, Metal	33.646	3,495	2.181	12,847
Manganese Ore	439,509	24.904	*	*
Lead, Pig and Sheet	157,985	14,744	6,828	50,715
Zinc (spelter)	53,324	5.805	3,314	23,918
	lb.	lb.	lb.	lb.
Quicksilver	2,556,214	7.504	4,568	77,016

EXPORTS OF COPPER FROM UNITED STATES

Reported every month by the United States Customs.

1916	Long tons	1916	Long tons	1917	Long tons
January	21,863	July	35,048	January	25,540
February	20,548	August	34,700	February	24,937
March	24,006	September	28,572	March	51,246
April	19,980	October	32,712	April	—
May	14,700	November	21,433	May	—
June	38,277	December	21,438	June	—
		Total 1916	313,277	Total 1917	101,723

OUTPUTS OF TIN MINING COMPANIES.

In Tons of Concentrate.

	Year 1916 Tons	April 1917 Tons	May. 1917 Tons	Year 1917 to date
Bisichi (Nigeria)	473	25	15	142
Briseis (Tasmania)	467	30	26	153
Dolcoath (Cornwall)	1,076	70	76	336
East Pool (Cornwall)*	1,012	90	90	449
Gopeng (F.M.S.)	1,113	79	91	419
Malayan Tin (F.M.S.)	1,104	50	64	300
Mongu (Nigeria)	576	42	36	258
Naraguta (Nigeria)	523	32	31	195
N. N. Bauchi (Nigeria)	578	40	45	215
Pahang (F.M.S.)	2,591	220	220	1,100
Rayfield (Nigeria)	658	50	50	250
Renong (Siam)	894	77	85	378
Siamese Tin (Siam)	906	65	68	365
South Crofty (Cornwall)*	700	55	59	283
Tekka-Taiping (F.M.S.)	651	30	35	172
Tongkah Harbour (Siam)	1,135	131	101	562
Tronoh (F.M.S.)	1,662	75	94	436

* Including Wolfram.

STOCKS OF TIN.

Reported by A. Strauss & Co. Long tons.

	April 30 1917	May 31, 1917	June 30, 1917
	Tons	Tons	Tons
Straits and Australian, Spot	2,758	2,149	2,595
Ditto, Landing and in Transit	879	1,255	50
Other Standard, Spot and Landing	401	359	293
Straits, Afloat	3,845	5,617	5,000
Australian, Afloat	325	85	85
Banca, on Warrants	—	—	—
Ditto, Afloat	3,130	1,541	2,567
Billiton, Spot	—	—	—
Ditto, Afloat	100	100	233
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,535	1,455	1,530
Afloat for United States	3,835	3,339	4,095
Stock in America	1,707	4,402	2,332
Total Stock	18,515	20,302	18,780

SHIPMENTS AND IMPORTS OF TIN

Reported by A. Strauss & Co. Long tons.

	Year 1916	June 1917	Total 1917
	Tons	Tons	Tons
Shipments from:			
Straits to U.K.	27,157	1,478	14,839
Straits to America	25,943	2,100	11,352
Straits to Continent	8,487	1,145	5,995
Australia to U.K.	2.537	—	349
U.K., Holland, and Continent to America	14,863	1.670	7,660
Imports of China Tin into U.K. and America	1,305	50	160
Imports of Bolivian Tin into Europe	15,116	2,015	8,991
Deliveries in U.K.	16,862	1,350	6,541
,, ,, Holland	943	81	354

NIGERIAN TIN PRODUCTION.

In long tons of concentrate of unspecified content.

Note. *These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.*

	1912	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531	665
February	240	427	469	358	528	631
March	247	510	502	418	547	645
April	141	430	482	444	486	543
May	144	360	480	357	536	479
June	121	321	460	373	510	...
July	140	357	432	455	506	...
August	201	406	228	438	498	...
September	196	422	289	442	535	...
October	256	480	272	511	584	...
November	340	446	283	467	679	...
December	310	478	326	533	654	...
Total	2,540	5,103	4,708	5,213	6.594	2,963

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 70% of Concentrate shipped to Smelters.

Long Tons.

	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons
January	4,121	4,983	4,395	4,316	3,558
February	3,823	3,555	3,780	3.372	2,755
March	3,562	3,839	3,653	3,696	3,286
April	4,066	4,087	3,619	3,177	3,251
May	4,319	4,135	3,823	3,729	3,413
June	3,993	4,303	4,048	3,435	3,489
July	4,245	4,582	3,544	3,517	...
August	4,620	3,591	4,046	3,732	...
September	4,379	3,623	3,932	3,636	...
October	4,409	3,908	3,797	3,681	...
November	3,976	4,085	4,059	3,635	...
December	4,614	4,351	4,071	3,945	...
	50,127	49,042	46.767	43,871	19,752

SALE OF TIN CONCENTRATE AT REDRUTH TICKETINGS.

	Long tons	Value	Average
Year 1915	4,918	£448,362	£90 14 6
September 11, 1916	184	£17,113	£93 0 2
September 25	166½	£15,980	£95 19 7
October 9	197	£19,143	£98 13 11
October 23	170	£17,167	£100 19 9
November 6	194½	£19,701	£101 5 10
November 20	172	£18,044	£104 18 2
December 4	160½	£16,588	£105 4 6
December 18	186¼	£19,031	£102 3 8
Total, 1916	4,668	£478,194	—
January 2, 1917	176	£17,677	£100 8 10
January 15	160¾	£16,681	£103 15 5
January 29	152	£16,095	£105 17 10
February 12	182¼	£20,649	£113 6 1
February 26	176¾	£19,700	£111 9 3
March 12	179	£20,468	£114 7 0
March 26	161¾	£19,875	£122 17 8
April 10	179	£22,024	£123 2 0
April 23	169	£21,429	£126 16 0
May 7	167	£22,248	£133 4 6
May 21	168¼	£23,772	£141 5 9
June 4	168	£22,474	£133 15 6
June 18	158½	£21,915	£138 5 4
July 2	159½	£21,661	£135 16 1

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:

GOLD, SILVER, DIAMONDS:	July 5, 1916 £ s. d.	July 5, 1917 £ s. d.
RAND:		
Bantjes	13 9	7 0
Brakpan	4 4 6	5 2 6
Central Mining (£8)	6 8 9	6 11 3
Cinderella	6 0	3 9
City & Suburban (£4)	1 18 9	1 13 9
City Deep	4 0 0	4 3 9
Consolidated Gold Fields	1 12 6	1 11 3
Consolidated Langlaagte	1 14 6	1 3 0
Consolidated Main Reef	1 0 0	17 0
Consolidated Mines Selection (10s.)	16 6	1 4 9
Crown Mines (10s.)	3 1 3	2 11 3
Daggafontein	15 3	15 9
D. Roodepoort Deep	14 6	11 3
East Rand Proprietary	15 3	9 0
Ferreira Deep	1 7 6	18 9
Geduld	2 4 6	2 0 0
Geldenhuis Deep	1 6 3	1 3 9
Gov't Gold Mining Areas	1 17 0	3 3 6
Heriot	2 10 0	2 2 6
Jupiter	7 9	5 0
Kleinfontein	1 9 6	1 0 3
Knight Central	12 0	4 0
Knight's Deep	1 8 9	18 9
Langlaagte Estate	19 0	16 6
Luipaard's Vlei	9 0	6 6
Main Reef West	7 3	4 6
Meyer & Charlton	5 11 3	5 6 3
Modderfontein (£4)	17 1 3	21 2 6
Modderfontein B	6 16 3	7 15 0
Modder Deep	6 13 9	7 2 6
Nourse	13 9	1 2 6
Rand Mines (5s.)	3 13 0	3 7 0
Rand Selection Corporation	3 5 6	4 0 0
Randfontein Central	11 0	12 6
Robinson (£5)	1 0 0	1 1 3
Robinson Deep	19 6	1 13 9
Rose Deep	1 5 0	19 6
Simmer & Jack	7 6	8 0
Simmer Deep	2 0	3 0
Springs	2 14 6	2 18 9
Van Ryn	2 3 9	1 17 6
Van Ryn Deep	3 10 0	3 5 6
Village Deep	1 10 6	1 5 0
Village Main Reef	17 6	15 6
Witwatersrand (Knight's)	2 18 9	2 2 6
Witwatersrand Deep	1 5 0	14 6
Wolhuter	10 6	8 9
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	15 0	16 3
Sheba (5s.)	2 3	1 3
Transvaal Gold Mining Estates	1 6 3	14 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	11 10 0	14 2 6
Jagersfontein	3 7 6	4 5 0
Premier Deferred (2s. 6d.)	5 5 0	7 11 3
RHODESIA:		
Cam & Motor	14 6	8 0
Chartered British South Africa	14 0	12 9
Eldorado	11 6	8 0
Falcon	16 0	16 3
Gaika	12 6	9 0
Giant	7 6	5 3
Globe & Phœnix (5s.)	1 6 0	1 12 6
Lonely Reef	1 3 9	1 3 0
Shamva	1 15 6	1 5 0
Wanderer (3s.)	1 6	2 0
Willoughby's (10s.)	5 9	5 3
WEST AFRICA:		
Abbontiakoon (10s.)	7 9	4 9
Abosso	10 6	9 0
Ashanti (4s.)	18 3	1 0 6
Prestea Block A	10 6	5 9
Taquah	19 3	17 9
WEST AUSTRALIA:		
Associated Gold Mines	4 6	3 0
Associated Northern Blocks	4 0	2 9
Bullfinch	5 0	2 0
Golden Horse-Shoe (£5)	1 15 0	1 17 6
Great Boulder Proprietary (2s.)	13 0	10 9
Great Boulder Perseverance	9	9
Great Fingall (10s).	1 9	1 0
Ivanhoe (£5)	2 3 9	2 2 6
Kalgurli	12 6	9 9
Sons of Gwalia	15 9	13 9

GOLD, SILVER, *cont.*	July 5, 1916 £ s. d.	July 5, 1917 £ s. d.
OTHERS IN AUSTRALASIA:		
Mount Boppy, New South Wales	10 0	6 0
Talisman, New Zealand	12 6	12 6
Waihi, New Zealand	1 17 0	1 13 9
Waihi Grand Junction, New Z'lnd	19 0	14 0
AMERICA:		
Alaska Treadwell (£5), Alaska	5 17 6	1 0 0
Buena Tierra, Mexico	12 6	10 0
Camp Bird, Colorado	9 3	6 9
Casey Cobalt, Ontario	7 0	8 0
El Oro, Mexico	9 6	10 0
Esperanza, Mexico	11 0	9 9
Frontino & Bolivia, Colombia	11 3	11 6
Le Roi No. 2 (£5), British Columbia	10 0	8 6
Mexico Mines of El Oro, Mexico	4 0 0	4 7 6
Oroville Dredging, California	17 0	17 0
Plymouth Consolidated, California	1 3 0	1 2 0
St. John del Rey, Brazil	16 6	17 6
Santa Gertrudis, Mexico	14 0	10 6
Tomboy, Colorado	1 2 6	19 6
RUSSIA:		
Lena Goldfields	1 12 6	1 12 6
Orsk Priority	1 0 6	1 0 0
INDIA:		
Champion Reef (2s. 6d.)	6 9	6 0
Mysore (10s.)	4 0 0	3 4 6
Nundydroog (10s.)	1 9 6	1 7 6
Ooregum (10s.)	1 2 6	1 0 3

COPPER:

COPPER:	July 5, 1916 £ s. d.	July 5, 1917 £ s. d.
Arizona Copper (5s.), Arizona	2 0 0	2 8 9
Cape Copper (£2), Cape Province	3 17 6	3 17 6
Chillagoe (10s.), Queensland	6	3
Cordoba (5s.), Spain	3 9	3 0
Great Cobar (£5), N.S.W.	3 6	2 3
Hampden Cloncurry, Queensland	1 18 9	1 11 9
Kyshtim, Russia	2 8 9	2 2 6
Messina (5s.), Transvaal	11 6	10 0
Mount Elliott (£5), Queensland	3 17 6	5 15 0
Mount Lyell, Tasmania	1 6 0	1 5 9
Mount Morgan, Queensland	2 0 0	1 13 0
Rio Tinto (£5), Spain	61 15 0	61 10 0
Sissert, Russia	18 9	1 2 6
Spassky, Russia	2 2 6	1 15 0
Tanalyk, Russia	2 5 0	2 0 0
Tanganyika, Congo and Rhodesia	2 13 0	3 10 0
Tharsis (£2), Spain	5 0 0	5 0 0

LEAD-ZINC:

LEAD-ZINC:	July 5, 1916 £ s. d.	July 5, 1917 £ s. d.
BROKEN HILL:		
Amalgamated Zinc	1 14 6	1 12 6
British Broken Hill	1 5 6	2 0 0
Broken Hill Proprietary (8s.)	3 0 0	2 8 0
Broken Hill Block 10 (£10)	1 3 0	1 2 6
Broken Hill North	2 7 6	2 15 6
Broken Hill South	8 7 6	8 15 0
Sulphide Corporation (15s.)	1 7 3	1 7 0
Zinc Corporation (10s.)	15 3	1 0 6
ASIA:		
Burma Corporation	3 1 9	4 5 0
Irtysh Corporation	2 3 9	2 0 0
Russian Mining	17 6	18 6
Russo-Asiatic	5 10 0	4 11 3

TIN:

TIN:	July 5, 1916 £ s. d.	July 5, 1917 £ s. d.
Aramayo Francke, Bolivia	1 7 6	1 11 3
Bisichi, Nigeria	9 6	15 0
Briseis, Tasmania	4 9	5 0
Dolcoath, Cornwall	12 6	10 0
East Pool, Cornwall	1 15 0	2 4 0
Ex-Lands Nigeria (2s.), Nigeria	1 3	1 9
Geevor (10s.) Cornwall	4 9	13 3
Gopeng, Malay	1 12 6	1 12 6
Ipoh Dredging, Malay	18 0	15 0
Malayan Tin Dredging, Malay	2 1 3	1 17 6
Mongu (10s.), Nigeria	8 6	13 0
Naraguta, Nigeria	13 9	13 9
N. N. Bauchi Pref. (10s.), Nigeria	6 0	10 3
Pahang Consolidated (5s.), Malay	11 3	11 9
Rayfield, Nigeria	6 0	7 6
Renong Dredging, Siam	1 10 0	2 15 0
Ropp (4s.), Nigeria	17 6	17 0
Siamese Tin, Siam	2 15 0	2 15 0
South Crofty (5s.), Cornwall	17 3	1 2 0
Tekka, Malay	3 10 0	3 3 9
Tekka-Taiping, Malay	2 5 0	2 17 6
Tronoh, Malay	1 10 0	1 6 3

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE CHEMISTRY AND METALLURGY OF TUNGSTEN.

At the June meeting of the Cornish Institute of Engineers, Mr. H. W. Hutchin read a paper on tungsten. We give herewith the section relating to the chemistry and metallurgy, and shall publish the part dealing with the estimation of tungsten in our next issue.

CHEMISTRY OF TUNGSTEN.—The atomic weight is 183·6, and the chemical symbol W.

Tungstic oxide, WO_3, is the most important compound. It is light yellow at ordinary temperatures, with heat orange-coloured; sometimes greenish, an indication of impurity. Specific gravity 6·35. Difficult to fuse, insoluble in H_2O, HCl, HNO_3, and aqua regia. Soluble in boiling solutions of NaHO and KHO; also in fused $KHSO_4$ and K_3WO_4.

Tungstic acid, H_2WO_4, is a yellow powder insoluble in H_2O and HNO_3, slightly soluble in HCl, easily soluble in alkalis, even ammonia. Formed by the action of acids on tungstates in hot liquors. A white powder, H_2WO_4,H_2O, is obtained by the action of acids on cold solutions of the alkaline tungstates. This compound loses H_2O on boiling and becomes yellow.

Potassium tungstate, K_2WO_4, is a white salt fusible at a red heat and then capable of taking up more WO_3. It becomes more fusible as it takes up more oxide. It is soluble in its own weight of cold water. The solution has a strongly alkaline reaction. The weakest acids, for instance, CO_2, cause the formation of acid salts which are less soluble. A strong cold solution of K_2WO_4 heated with strong acetic acid gives a white curdy precipitate of potassium paratungstate. This dissolved in 10 to 15 times its own weight of boiling water gives on cooling crystals of $5K_2O$, $12WO_3$, $11H_2O$. On fusion this splits up into the normal tungstate, K_2WO_4, and a more acid salt $5K_2O,14WO_3$, which is almost insoluble in water. In boiling aqueous solutions some such doubling probably takes place, and on adding acid it is rather an extremely acid salt than tungstic acid which is precipitated. It is almost impossible to precipitate tungstic acid free from potash with acids. Sodium tungstate, Na_2WO_4, is a white salt like the potash one; like it, it is prone to form acid salts. Sodium paratungstate, $5Na_2O,12WO_3,28H_2O$, when crystallized cold; when crystallized hot it contains $21H_2O$. It dissolves in 12 parts cold H_2O. In boiling solutions it forms a more and a less acid salt. Fused it suffers a similar change, and with water extraction leaves an insoluble acid tungstate. Ammonium tungstate, $(NH_4)_2WO_4$, is not known, though it probably exists in solution when tungstic acid is dissolved in ammonia. These solutions easily lose ammonia, and various acid tungstates have been separated. Ammonium paratungstate, $5(NH_4)_2O$, $12WO_3,11H_2O$, is only slightly soluble in water, and but little affected by the addition of ammonia. All the ammoniacal tungstates leave tungstic oxide on ignition in air. With the exception of $MgWO_4$, the tungstates and paratungstates of the other metals are insoluble in water and dilute acids. Strong acids decompose them with the formation of tungstic acid. Organic acids do not effect this change. Mercurous tungstate, Hg_2WO_4, is easy to work with, and convenient for separating tungstic acid from solutions. It leaves the oxide on ignition.

The tungstates may be prepared by adding a solution of the metallic salt to an alkaline tungstate. They may be prepared in the dry way often in good crystals by fusing an alkali tungstate with sodium chloride and a chloride of the metal.

Metatungstates are almost all very soluble in water and easy to get in good crystals. The mercurous and lead salts are insoluble and may be obtained as white precipitates. Metatungstic acid, $H_2W_4O_{13},8H_2O$, occurs as small white crystals extremely soluble in water. The liquid may be evaporated to a syrup, but on boiling yields tungstic acid. Sodium metatungstate may be prepared by boiling sodium paratungstate with an excess of tungstic acid for some time. On evaporating the liquid beautiful crystals may be obtained having the formula $Na_2O,4WO_3,10H_2O$. One part of cold water dissolves 10 of the salt, and boiling water dissolves it in all proportions.

Complex tungstates with phosphates, arsenates, borates, silicates, etc., are very numerous. If acid sodium tungstate solution is boiled with gelatinous silica, in place of tungstic acid, in preparing sodium metatungstates, the silica is dissolved, and the solution acquires an alkaline reaction. From the solution, crystals separate out, $4Na_2O,SiO_2,12WO_3,7H_2O$. The corresponding acid, silico-tungstic acid, $4H_2O,SiO_2,12WO_3$, is very soluble in water. It may be evaporated and dried at a temperature of 350°C without losing its solubility; at higher temperatures it is decomposed into SiO_2 and WO_3. Mercurous silico-tungstate is insoluble; the others are soluble. Sodium boro-tungstate may be prepared by adding 1½ parts of boric acid crystals to one part of sodium tungstate. On evaporating, acid borates of soda crystallize out, leaving a very dense solution which yields crystals with a formula $2Na_2O,B_2O_3,14WO_3,23H_2O$. The corresponding acid and nearly all the salts are soluble in water. Cadmium boro-tungstate, $2CdO,B_2O_3,9WO_3,23H_2O$, is very soluble; the saturated solution at 19°C has a specific gravity of 3·28. Sodium phospho-tungstate is formed by adding tungstic acid to a boiling solution of phosphate of soda. There are several of these: $3Na_2O$, P_2O_5, $24WO_3$, $27H_2O$, and $3Na_2O$, P_2O_5, $7WO_3xH_2O$. When a tungstate is attacked by phosphoric acid, there is no separation of H_2WO_4, as phospho-tungstates are soluble in water. Arseno-tungstates are like the phospho-tungstates. A salt, K_2O, $As_2O_5,6WO_3,3H_2O$, has been prepared by evaporating solutions of potassium arsenate and paratungstate together. The complex tungstates are stable in neutral and acid solutions but alkalis resolve them into their constituent salts.

Colloidal tungstic acid may be prepared by adding HCl to neutralize the soda in a 5% solution of Na_2WO_4 and dialysing. The solution may be evaporated to a jelly and heated to 200°C without losing its solubility, Its solutions are not coagulated by adding salts or acids when boiling.

The precipitation of tungstic acid from solutions of alkaline tungstates is likely to be incomplete, because of (1) colloidal tungstic acid, (2) silico, phospho, arseno tungstates, etc., (3) meta-tungstic acid. Moreover the product is impure because of the precipitation of insoluble acid tungstates. To separate the WO_3 pure the solution should be acidified with acetic acid, sodium acetate added, and then $HgNO_3$. The precipitate on ignition leaves WO_3. H_2S passed through solutions of sodium or potassium tungstate yields the correspondiug sulpho-tungstates, Na_2WS_4 and K_2WS_4. Many of the sulpho-tungstates are insoluble in H_2O. They may be formed by suspending the tungstate in water and passing H_2S or by adding an ammoniacal solution of the metal (for instance cadmium) to a solution of ammonium sulpho-tungstate. On adding a slight excess of acid to Na_2WS_4, WS_2 is precipitated as a liver-brown powder, which becomes black on drying. This precipitate is likely to contain WO_3. On heating WS_3 we get WS_2 and S. WS_2 as prepared in the dry way resembles molybdenite in some respects. Yellow tungstic acid or a metatungstate treated with dilute HCl and zinc is reduced to a copper red oxide WO_2. The blue colour obtained by a less complete reduction is the intermediate oxideW_2O_5. The penta-chloride of tungsten WCl_5 added to water gives the same blue colour. Potassium tungstate mixed with NH_4Cl and heated to redness gives a mass, which on extraction with water leaves the red oxide WO_2.

Acid tungstates of soda fused in an atmosphere of hydrogen or with tin yield tungsten bronzes. These are yellow, red, purple, or blue according to the method of their preparation. They resist the action of acids. They contain Na_2O, WO_2, and WO_3 in varying proportions. The blue bronze fused with neutral Na_2WO_4 becomes yellow by the subtraction of WO_3. Yellow bronzes fused with acid tungstate of soda become blue. In each direction there is a passage through the intermediate stages, Yellow bronze, $Na_4W_3O_9$; yellow-red $Na_4W_5O_{15}$, red-purple, $Na_4W_6O_{18}$; blue, $Na_4W_{10}O_{30}$. There are potash bronzes and others mixed with both alkalis.

Tungstic oxide (WO_3) heated in hydrogen to a dull red heat, 250-300°C, yields a blue oxide. The red oxide may be obtained at a red heat. The reduction is ultimately complete and the product is metallic tungsten. WO_3 is also reduced to metal by zinc vapour at a red heat. In the electric furnace, mixed with 10% charcoal, WO_3 yields the metal in masses fused on the outside and cellular and shining within.

The metal is extremely difficult to melt, but welds below fusing point. It may be filed, does not scratch glass, and does not attract a magnetic needle. Its specific gravity is 18·7. It is but little attacked by HCl, HF, or H_2SO_4. HNO_3 or aqua regia convert it rapidly into tungstic acid. At the temperature of the electric furnace it combines with carbon forming the carbine CW, which melts with less difficulty than the metal. It forms an iron-grey mass which easily scratches corundum. It reacts with acids just as tungsten does. A carbide richer in carbon than CW may be obtained in some iron alloys; it is left in the residue after dissolving in acids. It is not attacked by chlorine. Tungstic hexa-chloride, WCl_6, is obtained by attacking the metal with perfectly dry Cl, free from oxygen, as the tendency is to form oxychlorides. With water it forms HCl and tungstic acid. Tungsten heated in the electric furnace combines with boron, silicon, or phosphorus, forming metallic compounds.

A compound of tungsten fused with four times its weight of $KHSO_4$ and then treated with sufficient H_2SO_4 yields a liquid which on cooling gives a red colour with phenol. Phospho and metatungstic acids are sensitive reagents for the alkaloids, with which they give insoluble compounds.

METALLURGY OF TUNGSTEN.—Although the metal tungsten has a high melting point, 3080C°, it readily alloys with steel. Tungsten steel is used for the manufacture of self-hardening tools, the temper of which is not impaired by heat, and as a consequence may be driven much faster than carbon steel when used as machine-cutting tools. Ferro-tungsten assimilates yet more readily with molten steel. Tungsten steel is capable of a higher degree of magnetization than any other steel. It resists atmospheric corrosion and withstands the effects of sea water to a remarkable degree. The tungsten or ferro-tungsten is best added to the steel during the latter stages of manufacture. A tungsten steel with 5 to 6% of tungsten is very hard and tenacious, but workable. With 10 to 12% of tungsten the steel is so hard that it cannot be worked with the lathe and has therefore to be forged or ground.

In order to produce ferro-tungsten, the crushed tungsten ore is mixed with a calculated amount of iron oxide or scrap, 10 to 12% of powdered quartz, and 5% of rosin or pitch, and the mass placed in crucibles and smelted in a specially constructed furnace. A good commercial ferro-tungsten should have a percentage composition approaching the following: Tungsten 78·8, iron 15·9, carbon 3·2, silicon 1·87, sulphur 0·11, phosphorus 0·10. The maker of ferro-tungsten is very fastidious as to the purity of the tungsten ores; objections are made to manganese, arsenic, tin, copper, lead, bismuth, etc.

An alloy of aluminium and tungsten known as partinium is largely used in the construction of the bodies of automobiles. The alloy is very light and strong. Metallic tungsten in the form of a filament is used in certain kinds of electric lamps, and the manufacture of tungsten in this form is a distinct and special process.

Prior to the war, the production of metallic tungsten powder was wholly in German hands. Cornish concentrates were sold to German firms and returned to this country mainly as tungsten metal. About ten years ago a group of financiers interested in Cornish mines proposed to establish works in England to remedy this state of affairs, but meeting with scant support from an uninterested public and an apathetic government, the project was not carried to completion. The advent of war made the supply of tungsten metal or ferro-tungsten of vital importance, and the lack of it doubtless caused real delay in the production of munitions. The matter was solved by a combine of steel makers, who revived the abandoned scheme and carried it to a successful conclusion, under the title of the High Speed Steel Alloys, Ltd., and on the site originally purchased for the purpose. This firm is producing tungsten metal of quality superior to German make. Elsewhere in Great Britain other firms producing ferro-tungsten, etc., are operating successfully, for instance the Thermo-Electric Co., and the Continuous Reaction Syndicate.

The production of tungsten powder from wolfram is simple in theory, but difficult in practice. The chief points are: (1) fusion of the ore with carbonate of soda, producing tungstate of soda, (2) solution of the sodium tungstate in water, (3) production of tungstic acid by addition of hydrochloric acid, (4) reduction of the tungstic acid to metal by heating with carbon. The fusion with carbonate of soda is done in a reverberatory furnace, lined with a hearth of dolomite agglomerated with tar and burned in place. After fusion the melt is broken up, granulated, and digested with water in filter tanks, followed by methodic washing with nearly boiling water. The alkaline tungstate dissolves, also some silico, arseno, and phospho-tungstate. Soluble manganates are not very objectionable. To eliminate silica, arsenic, and phosphorus, hydrochloric acid is added to the boiling solution to form paratungstate soluble in hot solution, but crystallizing out when cold in fine prismatic crystals. Silico, arseno, and phospho-tungstates are more soluble and remain in the mother liquor. The paratungstate is transformed by addition of caustic soda to the normal tungstate, from which tungstic acid is precipitated by pouring the boiling solution into hydrochloric acid. To recover tungstic acid from the impure mother liquor, calcium carbonate is added and the precipitated tungstate of lime is treated by one of the methods applicable to scheelite. Berzelius has suggested a modification in which the alkaline tungstate solution is saturated with sulphuretted hydrogen, and then acidulated with hydrochloric acid. The tungsten is separated as the sulphide, WS_3, which is dried and roasted to WO_3.

Other processes have been suggested, of which a brief outline may be given: In the process of F. Jean, finely powered wolfram is mixed with 3% of calcium carbonate and 20 to 30% common salt, and heated for half an hour in a reverberatory furnace. The mixture when cold is powdered and treated with hydrochloric acid. Chlorine is usually liberated and the tungstic acid is left as a residue. The process is only applicable to pure wolfram, as silica, cassiterite, etc., will also be left in the residue. In the first of Gin's processes, a mixture of wolfram and chloride of magnesium is heated at 1,200°—1,300° C on a dolomite hearth reverberatory furnace. In the main, chlorides of iron and manganese, and tungstate of magnesium, are produced in the reaction. The heat is continued with an oxidizing flame to convert the chlorides of iron and manganese into peroxides. The residue is then extracted, first with a small quantity of cold water to remove soluble chlorides, and finally with boiling water to dissolve the magnesium tungstate. Ammonium carbonate in slight excess is added when the magnesium is precipitated as carbonate. The filtered solution contains ammonium tungstate which, when evaporated sufficiently, is deposited in crystals. The ammonium tungstate when heated is decomposed, leaving tungstic oxide.

In the bisulphate process, a muffle furnace with a hearth of silica agglomerated with pitch is used. The bisulphate is fused, with the orifices of the muffle closed, and then finely powdered wolfram is thrown in, continually stirred, and the temperature raised until the whole is fluid enough to run out. The mass after solidification is finely powdered and treated with water. Soluble sulphates of the metals are dissolved, and the tungsten remains as the insoluble potassium (or sodium) acid tungstate. 50% bisulphate excess is used to ensure complete attack, and to keep the solution sufficiently acid to ensure insolubility of the acid tungstate. The acid tungstate is dried and treated with warm water at 40°C containing ammonium carbonate. The following equation gives the reaction:

$$2K_2O,\ 5WO_3,\ 4H_2O + 5(NH_4)_2CO_3 = 2K_2CO_3 + 5(NH_4)_2WO_2 + 3CO_2 + 4H_2O.$$

Gin also gives a method for preparation of tungstic oxide by means of tungsten oxytetrachloride. The impure tungstic oxide obtained by any of the previous methods may be used. It is mixed with ferric sulphate and salt, and on heating to 400°C for a short time the following reactions occur:

$$3Fe_2(SO_4)_3 + 6NaCl = 3Na_2SO_4 + 2FeCl_3$$
$$3WO_3 + 4FeCl_3 = 3WOCl_4 + 2Fe_2O_3$$

The oxytetrachloride melts at 210°C and boils at 227°C It crystallizes in magnificent ruby red crystals, and is easily caught by condensation in a metallic condenser. Redistillation at 230° frees it from ferric chloride, which boils at 280°C. Water decomposes it into WO_3 and HCl.

In the preparation of WO_3 from scheelite, pure ores are decomposed by boiling with hydrochloric acid or nitric acid, giving a residue of WO_3. Impure ores are treated similarly, the WO_3 dissolved in NH_4, HO, and on concentrating the ammoniacal solution, ammonium tungstate crystallizes out. Fusion of scheelite with potassium fluoride in a reverberatory furnace produces soluble potassium tungstate and insoluble calcium fluoride.

With regard to allowable impurities in tungsten alloys, it is not rigorously necessary that tungsten should be free from carbon, and the carbide with 3% carbon may be employed in pearlite steels with a somewhat moderate tungsten content. For special steels for tool purposes, containing in general more than 10% tungsten, the carbon content is of much greater importance, but the question may be solved by the choice of a very soft steel, such as will keep the final carbon content under the requirements. To obtain uniform results the tungsten must be added in the form of pure metal or ferro-tungsten. Carbon must be absent in copper-tungsten alloys, as also in aluminium-tungsten alloys, or partinium. In platinoid, containing Cu 60, Zn 24, Ni 14, W 1 to 2 parts, the tungsten must be pure. For steel purposes there must not be more than 0·05% phosphorus, and not more than 0·1% sulphur; for high-speed tools not more than 0·5% manganese and 0·2% silicon.

UTILIZING THE SULPHUR CONTENT OF ZINC ORES.

On June 4, Mr. H. M. Ridge read a paper before the Society of Chemical Industry on the utilization of the sulphur content of zinc ores. He described, with illustrations, the various furnaces devised for roasting the blende, beginning with Hasenclever and the Rhenania, and passing to the Delplace, Hegeler, Merton, Wedge, Spirlet, and Ridge. He then proceeded to describe the utilization of the sulphurous gases. Their main commercial use is the manufacture of sulphuric acid. This can be carried out by the chamber process or by the contact process, and in both cases the plants are of the same design as when sulphur or pyrites is employed. Mr. Ridge makes mention of the way in which the particular impurities occurring with zinc ores affect the working of these processes.

Most zinc ores have the advantage of being free from arsenic. On the other hand they frequently contain fluorine of which even as little as 0·01 to 0·02% will cause trouble. Fluorine occurs with the ore as fluorspar, which is decomposed in the roasting furnace in the presence of silica to form silicon fluoride. If this gas passes into the Glover tower it is decomposed, and hydro-fluosilicic acid is formed; this, in turn, appears to split up. As it is usual when treating zinc ores to circulate the tower acids, the fluorine contents seem to remain in the circuit so that the attack on the packing of the towers gradually increases; but, contrary to expectations, the author has not found increased corrosion of the lead work of the chambers by fluorine. Many efforts have been made to overcome the trouble with the packing. Glover towers have been built entirely of lead, and with lead sheets as a packing, so as to avoid the use of silicious material, but it is necessary in this case to use two Glover towers in series, the first one being an empty tower, followed by a tower filled with suspended lead sheets. He has found it preferable to overcome the trouble by passing the whole of the chamber acid through the towers instead of only circulating the tower acid, by this means keeping down the fluorine contents of the acid, and at the same time to pack the towers with a well-burnt brick packing of a suitable composition which would offer the maximum possible resistance to the attack by hydrofluoric acid. Glover towers built in this way, and properly operated, have been worked continuously for 12 months and longer without trouble.

Other important impurities affecting sulphuric acid manufacture are antimony, mercury, and chlorine. Some years ago the author had trouble in consequence of the unexpected presence of chlorine, and on investigation found that this was due to the ore having been left lying for several months on the wharf at Port Pirie, where in order to avoid loss by wind it was sprayed with sea-water. Mercury is found with some Spanish blendes. It collects at the outer parts of the dish of the lead chamber, where it is not protected by lead sulphate and causes rapid corrosion of the lead. This can be overcome by lining the sides of the dish with thin brickwork. Antimony occurs frequently in small quantities with zinc blende, and at the high temperature of the roasting furnace some of this is volatilized and passes into the acid. On one occasion the author received complaints about the presence of arsenic, but found, on examination, that antimony was the cause of the trouble. Antimony was found in the zinc concentrates from Broken Hill when treating ore from the upper levels in one of the mines, but the quantity present was less than 0·03%. Most zinc ores have lead associated with them, and some of this is generally driven off with the sulphur in the roasting furnace together with the silver combined with the lead, but both the lead and the silver are deposited in the chamber sludge.

The lead chamber process, when working in conjunction with hand furnaces, has to be carefully watched because of the intermittent nature of the evolution of sulphur dioxide due to the intermittent rabbling of the ore. In Germany it has been usual to reduce this difficulty by arranging for the furnace hands, working on the different furnaces, to start their shifts at different times, but, in spite of this, it is not possible to obtain a continuous current of uniform gas throughout the 24 hours, and, unless the process is watched carefully, loss of nitre is the result. With modern mechanical furnaces this trouble does not occur.

In Great Britain and in Belgium chamber plants have been used exclusively for making acid, and in Germany this is also the rule, but there are several contact acid plants at work as well. In America 14 zinc smelters make sulphuric acid, and they mainly use the contact process. The use of the contact process in connection with zinc plant has made strides in the United States, because the smelters there are largely able to rely for their ore supplies upon the produce of one or more mines and are not dependent upon small parcels of ore shipped from various parts of the world, as has been the case in Great Britain and on the Continent. They have consequently been able to make provision for eliminating any harmful ingredients which may be present in the raw material treated over a long period. The American smelters also have the advantage of having practically no hand-rabbled furnaces. The various contact poisons can be eliminated if the tonnage to be treated warrants the initial expenditure on the plant. Fluorine, arsenic, antimony, and lead can be removed by first scrubbing the gas with a suitable liquid, and when this is done the conversion offers no greater difficulties than when brimstone or pyrites are burnt.

The sulphur fumes from zinc roasters can be used in the manufacture of liquid sulphurous acid. This process was started by Grillo at Hamborn in Westphalia, because the fumes from the roasting furnaces were low in SO_2, and it was, at that time, considered impossible to utilize them for making sulphuric acid. The furnace gases pass to a scrubbing tower sprayed with water, which dissolves the sulphur dioxide. The liquor gravitates to a series of pans placed over the burners, the heat of which is sufficient to drive off the SO_2. The gas, after being cooled, is compressed and liquefied at a pressure of 7 atmospheres. In Germany two plants are in operation, one at Hamborn and another at Lipine in Silesia. The method has not been employed in this country on the fumes from zinc ore, and the demand for liquid SO_2 is limited at present.

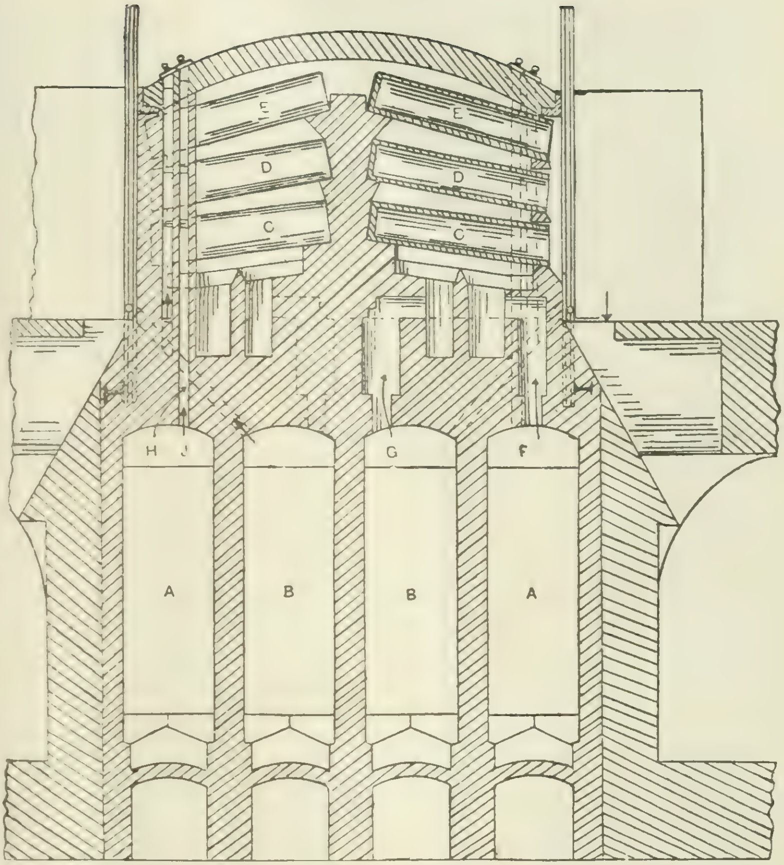
Iron-Silicon Alloys.—Metallurgists employing acid solutions have heard much recently of special iron-silicon alloys known as duriron, tantiron, corrosiron, etc., which are recommended for the construction or lining of vessels carrying acids, and for anodes in electrolysis. For instance, duriron is employed at Chuquicamata, having replaced magnetite in the manufacture of anodes. A paper on these acid-resisting alloys was read by O. L. Kowalke at the May meeting of the American Electro-Chemical Society. Information was given as to the theoretical constitution of these alloys, and then experiments were described relating to their acid-resisting powers. These alloys are brittle, and under some circumstances they are apt to break owing to internal strain. They have to be ground to shape instead of being machined. When the silicon content is from 3 to 5%, this brittleness is not so marked, but the alloy cannot withstand the attack of acid so well as when the silicon content is from 16 to 18%. Within the latter range of silicon content the resistance to the action of sulphuric, hydrochloric, nitric, acetic, and citric acids is at a maximum. Research is in hand with the object of finding a third constituent of the alloys that will increase their strength without affecting their acid-resisting power.

Concentrating Molybdenite by Flotation.—In our issue of May 1916, we quoted E. C. Andrews' account of methods of concentrating molybdenite ores in New South Wales. Further information on this subject is given in his monograph on the Molybdenite Industry of New South Wales, relating particularly to flotation methods recently introduced. We quote the description of one of these plants. At the Whipstick plant, 25 tons of hand-picked ore is treated per day. The ore is stamped to 20 mesh, passed over Wilfley tables, which remove a marketable concentrate of bismuth. The pulp, after the removal of the bismuth, goes to spitzkasten. The underflow goes direct to the mixer of a 12 in. Minerals Separation plant, and the slime overflow, after being de-watered in a Dorr thickener, goes to the same place. About ¾ lb. oil is added per ton of ore. The concentrates from the first three cells average 82 to 90% MoS_2. The concentrates produced in the second three cells are returned to the mixer for re-treatment.

Safety Carriage for Mines.—*The Engineer* for June 8 describes an apparatus for stopping mine cars on the downward journey on an incline when a certain maximum speed is exceeded.

Analysis of Rutile.—In *Metallurgical and Chemical Engineering* for May 15, E. W. Hagmaier gives a method of analysing rutile for titanic oxide, oxide of iron, and silicon.

Zinc Furnace.—*The Iron & Coal Trades Review* for June 8 gives particulars of the new zinc-smelting furnaces erected by the English Crown Spelter Co. of Swansea, built to the design of the manager, Mr. E. Ruck. These furnaces are a modified design of the Welsh - Belgian furnace. The general method of working this type of furnace is to heat the gas and air by passing them through their respective regenerators, and thence to conduct them through flues into a mixing chamber. From the latter the burning gases ascend into one-half of the heating chamber, in which two tiers of superimposed retorts are fixed, and after passing up to the roof of the furnace and heating the retorts, the gases descend through the other half of the heating chamber, in which again two tiers of retorts are contained, and pass finally into the regenerators from which they escape to the stack. It has hitherto not been found possible to work such a furnace with more than two tiers of retorts, owing mainly to the difficulty of properly heating the front parts of the retorts contained in the upper tiers. In Mr. Ruck's furnace, there are gas and air supply conduits in the front wall of the furnace structure, with their delivery outlets for the second and succeeding tiers situated in the neighbourhood of the front ends of the retorts in those tiers, leading to each of those ends a supply of gas and air for its requisite heating. The illustration shows A the air regenerators, and B the gas regenerators. Part of the hot gases from the regenerators pass upward over the retorts C, D, E, through passages F, G, while the front end of the retorts in the second tier are heated by the gases passing through the flues H, J, in the direction of the arrows. These passages have outlets in the neighbourhood of the front ends of the retorts. This arrangement leads to a substantial economy, both as regards fuel consumption and wages, as will be apparent from the figures obtained on a trial run extending over a period of some nine weeks. During this time 754 tons of dry ore, having a metal content of 46·54%, was charged into the two furnaces, the coal consumption per ton of ore being 1·15 tons, and per ton of metal 2·95 tons.



SECTION OF NEW FURNACES ERECTED AT THE WORKS OF THE ENGLISH CROWN SPELTER CO.

Magnetite Anodes.—As recorded in our issue of June 1914, electrodes of fused magnetite were supplied by a German firm for the electrolytic plant of the Chuquicamata copper deposits in Chile. It has already been recorded that these electrodes proved unsatisfactory owing to their extreme brittleness and that "duriron," a form of ferro-silicon, has been substituted. In *Metallurgical and Chemical Engineering* for May 15, M. DeKay Thompson and T. C. Atchison describe their experiments undertaken with the object of ascertaining the reason of this brittleness and of suggesting improvements. They experimented principally on the addition of copper oxide to the magnetite. This addition was found to reduce the corrosion slightly.

Wilfley's Flotation Machine.—In the *Engineering and Mining Journal* for May 19, C. R. Wilfley describes his "Cascade" flotation machine, used for treating the Wilfley tailings of a lead-silver ore at Mineral Farm, Ouray, Colorado. The plant consists of a series of boxes placed one above the other diagonally. The pulp is discharged from a spigot at the bottom of each box on to an apron which spreads it into a thin wide flow. When this flow plunges into the box below it causes sufficient agitation and introduction of air to form a floating concentrate.

Titanic Oxide Pigment. — *Metallurgical and Chemical Engineering* for May 15 gives particulars of the manufacture of a white pigment containing titanic oxide, a note of which was given in our "Recent Patents" last month.

Briquetting Metal Swarf.—*The Engineer* for June 8, 15, and 22 discusses methods and machines for compressing metal turnings and filings into briquettes, the object of this compression being to reduce the loss of metal as oxide in remelting operations.

Cost of Producing Copper.—The *Engineering and Mining Journal* for June 9 gives the following table of the cost of producing copper in cents per lb. at American copper mines. Several important names are missing from the list, notably Anaconda, Arizona Copper, and the Copper Queen and others of the Phelps-Dodge group. The method of calculating the cost varies. Some companies charge cost of plant, etc., to capital account and so make their figures attractively low. Others consider the value of the gold and silver recovered as a reduction of cost. None of the companies appear to charge amortization of plant and property account against the cost of production. In the table, the method of calculation employed by each company is not specified.

	Output for 1916 in lb.	Costs. in cents per lb.
Kennecott Copper	108,372,783	5·10
United Verde Extension	36,402,972	6·4†
Utah Copper	187,531,824	6·95
Champion Copper	33,601,136	7·8
Braden Copper	42,153,270	8·30*
Chino Copper	72,319.508	8·706
Shattuck Arizona	18,161,763	8·716
Mohawk Mining	18,468,100	8·85
Calumet & Arizona	74,898,788	9·04
Inspiration Consolidated	120,772,637	9·294
Nevada Consolidated	90,735,287	9·44
Miami Copper	53.518.331	9·525
Ray Consolidated	74,983,540	10·267
Allouez Mining	10,219.290	10·47
Magma Copper	8,473,580	10·803
Baltic Mining	12,425,804	10·85
Trimountain	8,720,558	11·1
White Pine Copper	4,207,449	11·22
Greene-Cananea Copper	62,250,067	11·352
Ahmeek Mining	24,142,158	11·47
Calumet & Hecla	76,762,240	11·63
Old Dominion Copper	17,654,643	11·69
Osceola Consolidated	19,586,501	11·69
Chile Copper	41,305,476	11·76*
Quincy Mining	21,065,612	12·642
Centennial Copper	2,367,400	13·44
Superior Copper	3,034,656	13·78
Tennessee Copper	9,404,295	14·36
Isle Royale Copper	12,412,111	15·32
Mass Consolidated	4,752,588	15·37
North Butte Mining	24,498,181	15·57†
East Butte Mining	18,340,713	16·8†
Shannon Copper	9,364,968	18·461
Victoria Copper	1,661,832	19·
La Salle Copper	1,380,352	19·96
Franklin Mining	3,116,566	20,22
Total	949,709,359	

* Cost at the plant. Owing to high insurance, freight rates, etc., the cost delivered was much higher. † Estimated.

Galvanizing.—In *Metallurgical and Chemical Engineering* for May 15, W. J. Harris describes a galvanizing bath for coating steel with zinc, in which the heat for keeping the zinc bath molten is supplied by gas which is burnt by the method of surface combustion. The principle of surface combustion was described in our issue of January 1912.

Concentration of Tungsten Ores.—In *Metallurgical and Chemical Engineering* for May 15, S. Fischer describes the concentration plants erected at mines and dumps containing wolfram and other tungsten ores in Boulder County, Colorado. The practice at a number of mills is given in detail.

Coro Coro.—In the *Engineering and Mining Journal* for June 16, Mark R. Lamb describes the concentrator to be erected at the Coro Coro copper mine, Bolivia, to treat 1,000 tons of native-copper ore per day.

Slime Settlement.—The *Engineering and Mining Journal* for June 16 publishes a translation of an article by G. Nicolai in *Metall und Erz* on methods used in Germany for removing lead and zinc slime from effluent waters so as to prevent pollution of rivers.

Regenerative Furnace for Copper Smelting.—W. G. Perkins. *Mining and Scientific Press*, June 2.

Siberian Mine-Timbering Methods.—Henry M. Payne. *Engineering and Mining Journal*, June 9.

Anaconda's Finances.—W. R. Ingalls. *Engineering and Mining Journal*, June 16.

Pazna Tin District, Bolivia.—F. C. Lincoln. *Mining and Scientific Press*, June 2.

Theory of Ore Flotation.—H. P. Corless and C. L. Perkins. *Mining and Scientific Press*, June 9.

Pilgrim's Rest Ore.—Robert Lindsay. *Journal* of Chemical, Metallurgical, and Mining Society of South Africa, April.

Geology of Charters Towers.—J. H. Reid. *Queensland Government Mining Journal*, February, March, and April.

RECENT PATENTS

15,180 of 1916 (106,050). D. B. JONES, Chicago, U.S.A. A method of distilling zinc ores, consisting of briquetting them with coal and placing them in an electric-resistance furnace. The patent evidently applies to the process described in our issue of April, page 220, under the heading "Fulton's Zinc Furnace."

10,433 of 1916 (106,187). P. R. KUEHNRICH, Sheffield. The addition of cobalt to carbon-chromium high-speed tool-steels. The inventor's steel averages 12% chromium, 3½% cobalt, and 1½% carbon. This is the patent mentioned in the advertisements in the daily press of the "cobaltcrom tungsten-less high speed steel."

18,602 of 1916 (106,241). J. E. GREENAWALT, New York. Improvement in charge-cars for ore-sintering plants.

9,100 of 1916 (101,285). F. A. EUSTIS, Boston, U.S.A. A method of treating nickeliferous iron ores, such as are found in Cuba, consisting of mixing with pyrite and roasting at a temperature that will give a maximum amount of soluble nickel sulphate.

636 of 1916 (103,310). O. NAGEL, Vienna. The inventor describes a process for recovering gold and other precious and rare metals from sea-water, by passing the water through adsorbent material such as crushed brick, the method of removal of organic substances, contained in the water, from the precipitation medium, being the special point of the claim.

13,523 of 1916 (106,400). E. L. LALBIN, Paris. Depositing aluminium electrolytically from the chloride which has been dissolved in a liquid containing no oxygen.

2,506 of 1916 (100,245). R. B. LOPART, Cordoba, Argentine. Making sulphate of zinc by roasting blende with zinc oxide and elemental sulphur.

NEW BOOKS

Economic Geology. By Heinrich Ries. Fourth Edition. Cloth, octavo, 856 pages, with many illustrations. New York: John Wiley & Sons; London: Chapman & Hall. Price 18s. 6d.

The first edition of this work was published in 1905, the second in 1907, the third in 1910, and the fourth (here reviewed) in 1916. By the amplification of existing matter and the addition of new, the book has steadily grown, not only in size but also in value. It now runs to rather more than 850 pages. Of these 425 are devoted to "Non-metallics," 200 to "Ore-deposits," and 25 to index.

In the first part the raw materials are described, in the main, according to their economic uses. Thus sections are devoted to fuels, building-stones, clays, limes and cements, gypsum, fertilizers, abrasives, and underground waters. Others of a more miscellaneous character refer to "salines and associated substances" and to "minor minerals." Under the last heading miscellaneous geological materials of economic importance are described in alphabetical order. The group includes, besides various substances of large utilization, such as asbestos, felspar, fuller's earth, graphite, mica, mineral pigments, precious stones, pyrite, silica, and talc, many others of more limited industrial application.

In the second part, after a preliminary discussion on ore-deposits in general, separate sections are given to the discussion of the sources and supplies of the major metals, iron, copper, lead, zinc, silver, and gold. The minor metals, including aluminium, antimony, manganese, mercury, nickel, platinum, tin, and others, are then dealt with alphabetically, as the minor minerals are in the concluding sections.

The relative size of the two parts into which the volume is divided is interesting, as affording a striking indication of the remarkable growth in the utilization of non-metallic minerals which has characterized the last few years, and in which American miners and manufacturers have played such an important part.

In the several sections the mode of occurrence and the natural history of the mineral substances referred to are described as fully as space will permit, and in most cases statistics of production are also provided. These latter apply more particularly to the United States and to Canada, but generalized figures for other important producing countries and for the world as a whole are often added. Moreover, copious references to relevant literature are given at the end of each section, indicating where further information concerning specific minerals may be obtained if required.

There are some 300 figures in the text, and 75 plates. Many of the latter are excellent pictorial representations of actual field occurrences, and serve to give the reader a better idea of the ways in which mineral deposits occur than could be afforded by text and diagrams alone.

Naturally there are in the volume statements which might be challenged, and views which could be criticized, seeing that even now after the enlightened study of mineral deposits for a quarter of a century and more, much evidence concerning them is inconclusive, and most theories are controversial. Such criticisms as suggest themselves, however, refer to details only, and do not seriously impair the general excellence of what the author has accomplished. In its earlier editions the book was already a very welcome contribution to the summarized literature on economic geology; in its revised and enlarged form it probably constitutes for this subject the most complete and serviceable work of moderate dimensions in the English language. It is much to be regretted that a comparable volume dealing with the mineral deposits and resources of the British Empire, as this one does with those of America, is not available. Such a work is more than ever needed just now, and would be welcomed not only by students of mineralogy and geology, but also by miners, metallurgists, and chemical technologists.

C.G.C.

Mechanical Handling of Material, and its national importance during and after the war. By G. F. Zimmer. This is a reprint of a series of articles published in *Cassier's Engineering Monthly*. It is issued by Crosby Lockwood and Son at 10s. 6d.

The Gold Deposits of the Rand. By C. Baring Horwood, A.R.S.M., M.Inst.M M., M.Inst.C.E. Cloth, octavo, 400 pages, with many illustrations. Price 15s. London: Charles Griffin & Co.

A notice of this book is given in our Editorial columns this month.

Molybdenum Industry in New South Wales. By E. C. Andrews. This monograph is published by the Geological Survey of New South Wales, at 10s. We quoted from advance sheets in our issue of November last, and in May 1916 we published notes by Mr. Andrews on concentration methods. In the new publication additional particulars are given of plants for concentrating the ore by flotation.

COMPANY REPORTS

Zinc Corporation.—This company was originally formed to apply the flotation process to zinc tailing at Broken Hill, and during recent years it has also operated the South Blocks mine. The zinc concentrator was closed on the outbreak of war, and was reopened early in 1916. The report for the year 1916 shows that 136,901 tons of ore, averaging 14·9% lead, 8·9% zinc, and 2·9 oz. silver per ton, raised from the South Blocks, was sent to the mill. The lead concentrate produced amounted to 29,478 tons, averaging 60% lead, 7·7% zinc, and 9·6 oz. silver. The zinc tailing produced amounted to 33,524 tons, averaging 16% zinc, 4·1% lead, and 1·7 oz. silver. At the zinc flotation plant, 200,510 tons of zinc tailing was treated, 46,305 tons coming from the lead concentrator, and 154,205 tons from the old dumps. The average content of the 200,510 tons was 14% zinc, 4·9% lead, and 5·4 oz. silver. The yield at the flotation plant was 48,313 tons averaging 48·2% zinc, 6·1% lead, and 10·2 oz. silver, together with 5,079 tons of lead concentrate, averaging 55·9% lead, 15·55% zinc, and 30·3 oz. silver per ton. In addition 3,283 tons of slime was impounded, averaging 36·25% zinc, 12·6% lead, and 22·75 oz. silver, to be treated subsequently by the Horwood process, which is not at work at the present time. The accounts show credits of £573,458 from the production or delivery of concentrates, and a net profit of £212,477. The preference shareholders received £92,134, being at the rate of 37½%, and the ordinary shareholders received £114,299, the dividend being at the rate of 35%. The development at the mine has proceeded satisfactorily. The reserve at the end of 1916 was estimated at 1,710,631 tons averaging 14·5% lead, 9·2% zinc and 2·6 oz. silver, as compared with 1,504,211 tons averaging 14·8% lead, 9·2% zinc, and 2·5 oz. silver the year before.

Amalgamated Zinc (De Bavay's).—This company was formed in 1909 in Australia to acquire the De Bavay flotation process, and it treats the current zinc tailing from the North, South, and Block 10 mines at Broken Hill for the production of zinc concentrate. The Australian royalties are pooled with those of Minerals Separation. The report for the half-year ended December 31 last shows that 171,856 tons of tailing was treated, for a yield of 47,321 tons of zinc concentrate, averaging 48·3% zinc, 6% lead, and 8·8 oz. silver per ton, and 1,095 tons of lead concentrate, averaging 53·8% lead, 11·3% zinc, and 56·9 oz. silver. The accounts show credits of £282,959 for concentrates sold and £110,026 for concentrates, chiefly zinc, unsold. The balance of profit was £93,281, out of which £8,750 was placed to equalization reserve, £10,440 was allowed for depreciation, and £75,000 was distributed as dividend, being 15% for the half year.

Great Boulder Proprietary. — This company was floated in London in June 1894 by G. P. Doolette and his friends for the purpose of acquiring gold-mining claims at Kalgoorlie, West Australia. Production commenced in April 1895, and in 1896 Richard Hamilton was appointed manager, a position which he still holds. The output has been remarkably regular, and for the last fifteen years the yearly production of gold has averaged over £550,000. The total yield from the beginning to the end of 1916 has totalled £10,643,441. About five years ago developments at depth began to give unfavourable results, but the reserves have been continuously maintained by exploration in the existing levels, and owing also to the stoping widths being proved to be wider than originally calculated. The report for 1916 shows that 175,787 long tons was raised and that gold worth £523,481 was extracted. The tonnage was less by 19,737 tons and the yield by £58,198 as compared with 1915, the difference being due to a labour strike that lasted for 21 days, and to subsequent shortage of ore delivered to the mill. The net profit was £246,539, and the sum of £262,500 has been distributed as dividend, being at the rate of 150%, the same rate as for the previous twelve years. The ore reserve is calculated at 439,677 tons averaging 14·68 dwt. per ton, as compared with 494,564 tons averaging 14·36 dwt. the year before, and 560,647 tons averaging 14·85 dwt. at the end of 1914.

Oroya Links.—This company was formed in 1896 as the Golden Link to acquire the Eclipse and other leases at Kalgoorlie, West Australia. It was reconstructed in 1902 and 1907. In 1909 further leases and a 50-stamp mill were acquired from the Oroya Brownhill company, and the name was changed. Bewick, Moreing & Co. are the general managers. Small dividends were paid for 1910, 1912, 1913, and 1914. Owing to the increase in costs and the consequent disappearance of a margin of profit, mining was discontinued in August last, and arrangements were made to let the property on tribute. The tributers' mill did not start until March last. The report for the year 1916 shows that from January to the end of August, 56,910 tons of ore was raised and treated, and gold worth £69,272 extracted. Royalties from tributers and other receipts brought the income to £79,094. The working cost was £77,959, allowance for depreciation of plant £4,914, London expenses £2,060, and income tax £1,750. The net loss for the year was £7,590. The ore reserve in the Eclipse section is estimated at 158,380 tons averaging 24s. 9d. per ton, together with 45,000 tons of probable ore. Recent developments have been mostly confined to the Eclipse, where ore continues to be disclosed, though of low grade.

Waihi Grand Junction Gold.—This company was formed in 1895 to acquire gold-mining property adjoining the Waihi mine, in the northern island of New Zealand. The lodes worked are north-easterly continuations of the Royal and Empire lodes in the Waihi. Milling started in 1906. F. C. Brown, inventor of the agitator-vat, was the first manager. He was succeeded in 1908 by W. F. Grace, who died six months ago. E. S. King has recently been appointed to the position. The report for 1916 shows that 125,780 tons of ore was treated, estimated to average 34s. 11d. in gold and 1·7 oz. silver per ton. The tonnage was the same as the year before, but the yield per ton showed an increase of 1s. 8d. in gold and 0·3 oz. in silver. The gold and silver produced were worth £222,736, and the net profit was £49,796, out of which £38,439 has been distributed as dividend, being at the rate of 10% free of income tax. In spite of scarcity of labour and delay in deliveries of pumps for depth, the development was maintained, and the reserve was increased by 21,300 tons, standing on December 31 at 157,700 tons.

Tekka.—This company was formed in 1907 by James Wickett, with headquarters at Redruth, to acquire the Sungei Raia alluvial tin property in the Kinta district of Perak, Federated Malay States. Osborne & Chappel are the general managers, and C. H. Preedy is manager at the mine. The report for 1916 shows that 496,040 cubic yards of ground was treated, for a yield of 491 tons of tin concentrate, as compared with 432,700 tons and 401 tons the year before, when much harder ground was being treated. The yield per yard was 2·2 lb. The revenue from the sales was £49,103, and the profit was £37,608, out of which £30,000 has been distributed as dividend, being at the rate of 37½%.

Siamese Tin.—This company was formed in London in 1906 to work alluvial tin deposits at Ngow, in the Renong district of the Western Siamese States. Cyril K. Butler is chairman, and H. G. Scott is general manager. The report for 1916 shows that all three bucket-dredges were at work, treating in the aggregate 1,865,200 cubic yards of ground for a yield of 903 tons of tin concentrate. The yield per yard averaged 1·085 lb. The income was £106,236, and the net profit was £27,909. The dividends absorbed £30,000, part of which was provided out of the balance brought forward from the previous year.

Tronoh South.—This company is a subsidiary of the Tronoh Mines, and was formed in 1911 to acquire alluvial tin properties in the Kinta district of Perak, Federated Malay States. The ground has not been so profitable or easy to work as that in some of the adjoining properties. Operations have been confined recently to the "clay lead." The report for 1916 shows that 301 tons of tin concentrate was extracted, selling for £30,921. The profit was £4,476, out of which £2,500 has been distributed as dividend, being at the rate of 2½%. The lead is now practically exhausted up to the Tronoh boundary, but at the other end additional profitable ground has been proved. Boring operations are being conducted at other parts also.

Idris Hydraulic Tin.—This company is a subsidiary of the Tronoh Mines, and was formed in 1913 to acquire alluvial tin properties in the Kinta valley, Perak, Federated Malay States. Osborne & Chappel are the general managers, and F. H. May is manager at the mine. The report for 1916 shows that at the Batu Karang, the pump-dredges treated 363,000 cubic yards for a yield of 168 tons of tin concentrate. At Snudong 112,561 yards was treated for a yield of 31 tons, and at Kranji 136,900 yards yielded 70 tons. The total output was 296 tons, selling for £28,192. The profit was £7,354, out of which £6,000 has been distributed as dividend, being at the rate of 5%. The output was rather lower than during the previous year, owing chiefly to the drought and the delay in getting the new hydro-electric power plant to work.

Seoul Mining.—This company was formed in 1908 under the laws of Connecticut, U.S.A., to acquire the Suan gold-copper-bismuth mine in Korea, from the Collbran-Bostwick Syndicate. The property had been previously operated unsuccessfully by a British company, the Korean Syndicate. At first the ore was worked chiefly for its gold, as it was impossible to recover more than 20% of the sulphide content of the ore by water concentration. More recently a Minerals Separation flotation plant has effected a radical change in results, and amalgamation has been suspended. The report for 1916 shows that the Suan mine is nearing exhaustion, only sufficient ore remaining to last for the current year. On the other hand, developments at the Tul Mi Chung mine are good. The Soctarie deposit, containing tungsten, copper, and gold, is being investigated, and experiments are being made on the complex concentrate obtained. During the year 66,753 tons of Suan ore was treated, yielding gold worth $644,366, copper worth $243,705, and bismuth worth $43,067, total $931,139. At the Tul Mi Chung mine, 109,765 tons was treated for a yield worth $892,628. The details of the yield are not given, but apparently the relative proportions of gold and copper are much the same as those at Suan, while silver is produced instead of bismuth. The reserve, fully and partly developed, is estimated at 474,500 tons averaging \$6·36 gold per ton, 1¼% copper, and 0·6 oz. silver. The profit for the year was \$918,502, out of which \$40,000 was allowed for depreciation, \$350,000 was placed to reserve, and \$250,000 was distributed as dividend, being at the rate of 50%. H. Collbran is president of the company, and A. R. Weigall is consulting engineer and general manager.

St. John del Rey.—This company operates the deepest and oldest gold mine in the world, in the State of Minas Geraes, Brazil. George Chalmers has been the manager for nearly thirty years. The report for the year ended February 28 last shows that 198,586 long tons of ore was raised and 187,400 tons treated, yielding gold worth £471,247. The yield per ton was 50s. 3d., of which 35s. 10d. was extracted on the blankets, and 14s. 5d. by cyanide. The working cost was £286,401, £29,253 was paid as duties, etc., £10,000 was placed to reserve fund, and £50,000 was transferred to capital expenditure account. The preference shareholders received £10,000, being 10% free of tax, and the ordinary shareholders received £54,626, at the rate of 10% less income tax. The lowest horizon, No. 20, at 5,826 ft. vertically below outcrop had been proved for 935 ft. at the time of writing, May 1, but neither the full length nor width had been exposed. The quality of the ore is quite equal to that found in the levels immediately above. Owing to the pitch being flatter in depth, the area of the ore-body in the horizontal plane is becoming greater. The ore reserve is equal to about 5½ years' supply, a substantial increase during the year. Development of horizon 21, at a depth of 300 ft. below No. 2, is now being prepared, and the ore-body should be exposed throughout its length by the end of 1917. The demand for manganese ore has induced the manager to examine some of the deposits belonging to the company, and one of them has been found worth mining. It is proposed to develop this, and concurrently to develop the Mutuca bauxite deposit. Concessions have been obtained from the Government to explore gold gravels on one of the rivers. Some of the stretches on the river are held by local concessionaires who are trying to sell their rights to the company. It is doubtful, however, whether the deposits would stand the expense of purchase.

Ouro Preto Gold Mines of Brazil.—This company was formed by John Taylor & Sons in 1884 to acquire the Passagem gold mine, near Ouro Preto, Brazil. The mine is in the same district as the St. John del Rey, but the ore is of lower grade and the profits have been very small. In 1914 the capital was severely written down, and a proposal was made to issue additional preference capital in order to expand the scale of operations. This proposal has, however, been suspended. The report for 1916 shows that 87,600 tons of ore was treated, the largest yearly amount yet recorded, for a yield of gold worth £121,223. The working cost was £114,830, and £5,487 has been allowed for depreciation. The reduced preference shares received their 10% dividend, amounting to £1,221. The ore reserve is estimated at 72,316 tons. A. J. Bensusan, the manager, reports that development was conducted at an increased rate, and that several useful discoveries have been made, the probable ore, in addition to the reserve, being equal to over a year's supply to the mill.

Esperanza.—This company was formed in London in 1903 to acquire the bulk of the shares of an American company that works the Esperanza gold mine at El Oro, Mexico. Big profits were made for eight years, but subsequently the yield has been on a much smaller scale, much of the ore coming from reclamation. The Mexican unrest has caused two stoppages recently, and the high costs now ruling for labour and supplies threaten to make a large proportion of the remaining ore unprofitable. The report for 1916 shows that mining was resumed in April of that year, and that 113,921 tons of ore was treated for a yield of bullion worth \$759,959 (U.S. currency). The profit was \$189,850, out of which \$56,250 was declared as dividend by the American company. The English company has declared no dividend for 1916, but is now paying an interim dividend for 1916 at the rate of 5%, absorbing £22,750. The reserve was estimated at 112,000 tons on December 31, but since then it has been found necessary, as already mentioned, to eliminate a large proportion of the ore from the payable reserve, and it is not likely that milling will be continued for long. H. A. Titcomb is consulting engineer, and Charles Hoyle manager.

Antelope Gold Mine.—This company was formed in 1908 to acquire gold-mining claims 60 miles south of Bulawayo, Rhodesia. The control passed in 1912 to the Gold Fields Rhodesian Development Co. Milling was started in 1913. The report for the year 1916 shows that 45,927 tons of ore averaging 10·3 dwt. was treated for a yield of gold worth £93,023. The cost including income tax was £87,413, leaving a profit of £5,610. During the year, certain old investments, made before the present board came into control, have been realized at prices much below the original cost. Out of the sum thus received, the debt to the Gold Fields Rhodesian company, £24,000, has been liquidated. The loss on realization, £55,986, has been charged to profit and loss account. Development during the year has disclosed ore of excellent grade in the 10th level, and it has also been found that the ore-body is wider at some parts than was originally calculated, so that the reserve has been maintained, standing at 101,392 tons averaging 10·1 dwt., as compared with 110,157 tons averaging 9·47 dwt. the year before. Further development, however, is necessary at and below the 12th level, and increased work in this direction is being planned by the consulting engineer, Cyril E. Parsons.

Robinson Deep.—This company was formed in 1915, when the Robinson Deep Gold Mining Co. absorbed the property of the Booysens Estate. The original company was formed in 1898 to acquire property in the central Rand, below the Ferreira Deep and Crown Deep. The control is with the Consolidated Gold Fields. The report now issued covers the 18 months ended December 31 last. During this time, the ore raised was 1,023,125 tons, and after the rejection of waste, 965,400 tons was sent to the mill. The yield of gold was worth £1,383,567, or 28s. 7d. per ton milled, and the working cost was £946,862, or 19s. 7d. per ton, leaving a working profit of £436,705, or 9s. per ton. Out of the profit, £100,000 has been distributed among shareholders in the old Robinson Deep company, and £200,000 has been distributed among the holders of preference shares in the new company. The ore reserve is estimated at 1,814,000 tons averaging 6·16 dwt. per ton. It has been necessary to abandon No. 2 vertical shaft and No. 2 incline shaft, and to rely on No. 1 vertical shaft. The new vertical shaft, named "Chris," had been sunk to 1,431 ft. by December 31, and is expected to be completed in two years time. Ore of excellent grade has been disclosed in the Booysens area.

Village Main Reef.—This company was formed in London in 1890 by the Consolidated Gold Fields to acquire from a South African company a mine in the central Rand below the Salisbury, Jubilee, and the western part of the City & Suburban. The remains of the Wemmer outcrop property were acquired later. During recent years the technical management has been with the Rand Mines. The mine is near its end, and during the last year or two the operations have been greatly hindered by caving. The report for 1916 shows that 390,138 tons of ore was raised, and after the rejection of 14% waste, 333,885 tons averaging 7·5 dwt. was sent to the mill. The yield of gold by amalgamation was 83,744 oz. and by cyanide 32,004 oz., making a total of 115,748 oz., worth £480,979, or 28s. 9d. per ton milled. The working cost was £319,341, or 19s. 1d. per ton, leaving a working profit of £161,638, or 9s. 8d. per ton. The shareholders received £118,000, being at the rate of 25%. The rate of dividend for 1915 was 55%, and for several years before it was 70%. H. Stuart Martin, the consulting engineer, reports the reserve at 750,204 tons averaging 6·6 dwt. He is of opinion that profits can be earned for another three years, though on a much lower scale.

Jupiter Gold.—This company was formed in 1896 by the Consolidated Gold Fields to acquire a deep-level property below Geldenhuis Deep and Jumpers Deep in the near east Rand. Milling was started in 1908, but suspended in 1913. Operations were resumed in 1915. The report for 1916 shows that 269,900 tons of ore was sent to the mill, and that the yield of gold was worth £298,292, or 22s. 1d. per ton. The working cost was £257,631, or 19s. 1d. per ton, leaving a profit of £40,661, or 3s. per ton. The shareholders received £88,742 or 8¾%, provided chiefly by funds accumulated from previous years. The reserve of ore in the Howard section, the only part at present worked, is estimated at 696,000 tons averaging 5·1 dwt. C. D. Leslie, the superintending engineer, states that the policy of selective mining will have to be continued in order to make a profit.

Simmer Deep.—This company was formed in 1906 by the Consolidated Gold Fields for the purpose of consolidating several companies owning deep levels below the Simmer & Jack, Rose Deep, and Glen Deep, in the eastern part of the central Rand. Milling commenced in 1908 at a plant owned conjointly with the Jupiter. The report for 1916 shows that 761,420 tons of ore was sent to the mill, and that the total yield of gold was worth £682,067, or 17s. 10d. per ton. The working cost was £625,602, or 16s. 5d. per ton, leaving a working profit of £56,465, or 1s. 5d. per ton. No dividend has ever been paid. The share capital is £1,650,000, and there are £731,300 debentures outstanding. The reserve is estimated at 1,246,000 tons averaging 4·56 dwt.

Roodepoort United Main Reef.—This company belongs to the Albu group, and owns outcrop and deep-level properties in the west Rand. It was formed in 1887, and there have been several rearrangements and amalgamations. Dividends were paid from 1894 to 1910. In the latter year the parent company advanced funds for pushing development and erecting a modern mill. The report for 1916 shows that 458,260 tons of ore was raised, and after the rejection of 10% waste, 412,845 tons was sent to the mill. The yield of gold by amalgamation was 67,579 oz. and by cyanide 30,943 oz., being a total of 98,522 oz., worth £411,314, or 19s. 11d. per ton milled. The working cost was £368,043, or 17s. 10d. per ton, leaving a working profit of £43,271, or 2s. 1d. per ton. Out of this profit £23,076 was paid as interest on the loan. The ore reserve is estimated at 677,273 tons averaging 6 dwt., together with 110,776 tons of partly developed ore averaging 6·87 dwt. The reserve is 43,036 tons less than a year ago, but 0·13 dwt. higher in value, the difference in relative figures being due to the elimination of unpayable blocks. The development of the Kimberley Main section continues to disclose satisfactory ore, and before long there should be a sufficient number of stope faces to provide ore of a grade higher than the average of the last few years.

Durban Roodepoort Deep.—This company belongs to the Rand Mines group, and owns property in the west Rand, on the dip of the Durban Roodepoort and Roodepoort United. Milling commenced in 1898, and the first dividend was paid in 1908. The profits have never been on a large scale. The report for 1916 shows that the yield per ton continued to decrease slightly. The ore raised was 363,228 tons, and after the rejection of 12% waste, 319,200 tons, averaging 6·6 dwt. per ton, was sent to the mill. The yield of gold was worth £414,532, or 25s. 11d. per ton, and the working cost was £373,699, or 23s. 4d. per ton, leaving a working profit of £40,833, or 2s. 7d. per ton. Shareholders received a dividend of £11,000, at the rate of 2½%. It was not deemed wise to distribute more, as funds are required for underground winding plant. The reserve is estimated at 1,259,300 tons, averaging 6·3 dwt. per ton, the amount being practically the same as last year, but the assay-value being lower by 0·2 dwt. Of the reserve, about one quarter is in pillars and averages 7·2 dwt.

Durban Roodepoort.—This company has its office in London, and is not connected with any of the big houses. It is notable for having paid dividends regularly since the beginning in 1888, a statement that cannot be made of any other company operating in the Roodepoort area. Sir. H. Ross Skinner was manager for a great number of years, and has been latterly consulting engineer. The ground is now nearly exhausted and it is doubtful whether operations will continue far into 1918. The report for 1916 shows that 204,978 tons of ore was raised, and after 15% was rejected as waste, 173,674 tons was sent to the mill. The yield of gold was worth £173,350, or 19s. 11d. per ton milled. The mining cost was £138,088, or 15s. 10d. per ton, leaving a mining profit of £35,261, or 4s. 1d. per ton. The shareholders received £25,000, being at the rate of 20%. The payable ore reserve on December 31 was estimated at 135,060 tons. The total yield of gold since the commencement has been £5,051,507, and the total dividends £1,472,583, on a capital which has stood since 1892 at £125,000.

Bantjes Consolidated.—This company was formed in 1887 to acquire property on the outcrop in the middle west Rand, but milling was not started until 1910. At first, good profits were made from South Reef ore, but four years ago developments because unsatisfactory. For the last year or so attention has been turned to the Main Reef Leader, which gives promise at several points. The report for 1916 shows that 294,249 tons of ore was raised, and after the rejection of 5% waste, 279,400 tons, averaging 5 dwt. per ton, was sent to the mill. The yield of gold was worth £286,543, or 20s. 6d. per ton, and the working cost was £295,870, or 21s. 2d. per ton, resulting in a loss of £9,326. The development during the year disclosed 160,330 tons in the Leader, and 29,114 tons in the South Reef, but on the other hand it has been necessary to withdraw some of the ore from the South Reef reserve owing to its proving unpayable. The reserve now stands at 198,300 tons in the Leader, averaging 5·8 dwt., and 213,700 tons in the South Reef, averaging 5·5 dwt., and making a total of 412,000 tons averaging 5·6 dwt. Of this total, 336,850 tons, averaging 5·45 dwt., is available for stoping, the remainder being in pillars. The reserve shows a fall during the year of 236,000 tons and 0·5 dwt. The control is with the Rand Mines.

COMPANY MEETINGS and REPORTS SECTION

CENTRAL MINING & INVESTMENT CORPORATION, LIMITED.

Directors: Sir Lionel Phillips (*Chairman*). Vicomte G. de Breteuil, Sir R. Sothern Holland, O. Homberg, T. J. Milner, G. Rouliot, Major R. W. Schumacher, Sir H. Ross Skinner, L. Wagner. *Managers in London:* F. Heim, P. Troquet. *Managers in Johannesburg:* H. C. Boyd, F. Raleigh, E. A. Wallers. *Assistant Manager in London:* A. W. Rogers. *Secretary:* L. Bluen. *Head Office:* 1 London Wall Buildings, London, E.C. *Secretary in Johannesburg:* C. Distel. *Johannesburg Office:* The Corner House. *Consulting Engineer in London:* H. F. Marriott. *Formed* 1905. *Capital:* £3,400,000, in 425,000 shares of £8 each.

Business: The financing of and investment in gold-mining properties particularly on the Rand and elsewhere in South Africa. Has interests also in Swaziland Tin, Prestea Block A, Magadi Soda, Cordoba Copper, and Trinidad Leaseholds.

THE twelfth ordinary general meeting of the Central Mining & Investment Corporation, Limited, was held at No. 1 London Wall Buildings, London, E.C., on June 14, Sir Lionel Phillips, Bart., presiding.

The Secretary, Mr. L. Bluen, having read the notice convening the meeting, and also the auditors' report,

The Chairman addressed the meeting as follows: The accounts for 1916 show an increase in net profits of about £40,000 over those of the previous year, but this does not indicate the full improvement, as the profit and loss accounts are not strictly comparable. Hitherto the dividends received on mining shares were recorded in full, while this year part of that revenue as well as a portion of the income from other sources has, in accordance with my previous recommendations, been treated as repayment of capital. We were thus able to apply quite a substantial amount to amortize wasting assets. A dividend of 8s. per share, free of income tax, was declared in December and paid in January in respect of last year's operations. It is now proposed to place £150,000 to reserve, and to carry forward the balance of £70,862 to the new account. I think these proposals will commend themselves to you, as it must be our aim under prevailing conditions to husband our resources.

The balance sheet is drawn up on lines with which you are familiar, the most important change recorded being the reduction of the capital to £3,400,000, Our liabilities to creditors, £3,787,000, are about £180,000 higher than last year. The bulk of this large amount consists of deposit and current accounts of the companies associated with us, whose accumulating credits are to a large extent repaid every year in February and August, when the dividends of the gold-mining companies become payable. We endeavour to secure for these amounts the best rates of interest compatible with absolute safety, and I may be permitted to reflect with satisfaction on the efficiency and care with which this responsible work, involving daily transactions of importance, is carried out.

A new departure has been made on the asset side of the balance sheet. Holdings, which used to be shown "at or under cost," are now entered "at or under market price." The writing down of capital enabled us to adopt this sound system. I may say that the writing down was practically spread over the whole range of your investments; unquoted interests and securities, whose marketability is restricted, being specially selected for drastic treatment. Furniture account has disappeared, and some details follow which disclose the extent to which the pruning knife has been applied. Additions made during the year to your holdings in British Government stocks and other readily realizable securities absorbed £436,000, raising these investments to £3,380,000. Cash, Loans and Debtors, £1,200,000, show a decrease of about £117,000, mainly due to the setting aside of reserves. The item of "Securities in Enemy Countries" appears at £200,000, as against £560,000 last year. Your other interests and investments show an important decrease in book values of £1,340,000. Realizations account only for a small portion of this amount. The bulk is represented by severe writing down of assets which on the whole have not materially altered either in composition or quantity. A very strong position has been thus established.

With your permission I will now briefly refer to those of your interests that call for special comment, and make a few observations upon general conditions affecting them. As nearly six months have elapsed since the close of our financial year I shall include information of more recent date. Your 4½% War Loan has been converted into the 5% Stock, of which a further amount has been taken. We were also instrumental in securing substantial applications from several of the gold-mining companies, which have in addition invested some of their surplus funds in war issues made by the Government of the Union of South Africa. We gave facilities to the members of the staff who desired to participate in the last great war loan, and a few friends applied through us, with the result that we were able to subscribe for approximately £1,000,000.

Turning to South Africa, we have increased our holding in the Rand Mines, Limited, and their report just to hand gives particulars of their subsidiary companies and of the new interests acquired on the Far Eastern Rand.

On the subject of deep levels in the mines of the Witwatersrand, I stated last year that experience showed that richer zones sooner or later give place to poorer zones, and *vice versâ*. This year I am able to furnish some rather striking corroboration, especially as to the development of the Main Reef Leader at the deepest levels in the Central area. The distance from the west of the Crown Mines to the east of the City Deep is about six miles. I take the lowest levels in each mine which are driven a sufficient length to give representative results. The reserves between the 15th and 16th levels on the Crown Mines are valued at 31·1s. per ton. Next, to the east, is the Robinson Deep, where recent disclosures south of the dyke in the Booysens area show over a short distance Main Reef Leader assay values of 42s. over a stoping width. Farther eastward in the Village Deep the 20th level ore reserves are estimated at 32·5s. per ton. This level, however, is only on the fringe of the disturbed area to which I make reference later on. At the adjoining mine on the east, the City Deep, the average value of the ore reserves on the 13th level is 33·8s. per ton. This level has yet to be driven through ground in which higher values are expected. These instances give no small evidence to justify confidence in the future of this section of the great goldfield in which the Rand Mines, Limited, and ourselves are largely interested.

CROWN MINES.—I spoke to you at some length last year about the Crown Mines, Limited. The immediate returns from this mine continue to give us concern. The yield has slightly improved during the year, but working costs have also risen considerably, and thus again reduced the profit per ton milled. Some of the mines are more adversely affected by the extra cost due to the war than others, owing in some measure to the varying requirements of stores and other causes. The Crown Mines is one of the hardest hit in this respect. The experiment resorted to last year of largely increasing the percentage of hand-stoping proved unprofitable at this mine, and we have had to reconcile ourselves to the larger stoping widths. The recalculation of ore reserves at the end of the year under review suggests an increase in tonnage and a slight decrease in value. New developments, however, during the year, which show that 60% of the distance driven was on payable reef averaging 7·9 dwt., or 33s., over the stoping width, taken in conjunction with other deep level developments to which I have already drawn attention, must be considered a distinctly favourable sign. Incidentally, I may say that at a deeper horizon, and below the great dyke which intersects this property, the Main Reef Leader was intersected in a bore-hole giving an assay value of 2,250 inch-pennyweights. This phenomenally high value applies only to one point, and I therefore lay no particular stress upon it. The outlook on the whole, therefore, is rather more encouraging than last year. This company has now acquired the mining rights under the machine stands and water rights from the Government. This facilitates development operations and adds to the reserves, but the ore so far exposed is rather poor.

CITY DEEP.—The addition of a Butters filter to the slime plant has raised the capacity of the reduction plant to 80,000 tons monthly. The attainment of this output is, however, dependent on an adequate native labour supply, which at the moment is rather deficient. The ore reserves have been largely increased, with some reduction of average value to 38s. per ton. The extraordinarily high results that have been recorded in this mine bid fair to continue. For the first quarter of the present year 2,000 ft. driven have disclosed 168,000 tons of an average grade of 11·2 dwt., or 47s. per ton. When I reflect upon the bad esteem in which this property was once held, and review its present position, I take some comfort in regard to mines which at the moment are less promising.

VILLAGE DEEP.—The yield from this mine continues to increase, and the ore reserves, while somewhat reduced in tonnage owing to the lower portion of the mine passing through a section of unproclaimed ground (in which the drives do not therefore at present add to the reserves), have also increased in average value. In the central section there is a disturbed area of unpayable ground, the development of which is not yet sufficiently advanced to determine its extent. The company recently acquired the mining rights adjoining the deepest section of its property under the Wemmer Pan. This ground is opening up well.

BANTJES.—My reference to this mine last year was, I fear, too sanguine, as the subsequent opening up by winzes and rises did not bear out the results previously obtained from the drives. The most recent developments on the Main Reef Leader give promise of fair payability. A loan has been granted to the company by your corporation and the Rand Mines jointly.

EAST RAND PROPRIETARY MINES.—The outlook at this company is, I regret to say, still unsatisfactory. Apart from the disquiet caused by the low-grade ore under development, the great volume of water encountered has vastly accentuated the difficulties. Arrangements have been made to tackle this problem by means of the cementation process, which has proved very effective in England. The services of the inventor were secured and he has started work on the 26th level cross-cut. He expresses himself confident of success, and upon this assumption it will be possible to renew operations on the lower areas without recourse to new pumping plant, costly to establish and operate. Previous experience of poor zones will, I trust, be repeated here in the discovery of a better ore. It has been decided simultaneously to sink a circular shaft from the surface to tap the lower areas. I am bound to say, however, that the situation gives ground for considerable anxiety, and we shall follow the work of the next twelve months with special attention.

NEW MODDERFONTEIN.—In view of the war having delayed the equipment of the deep-level circular shaft, the addition to the reduction plant will probably not come into operation as early as expected. The excellent grade of the newer development continues, and the deepest exposures in the circular shaft section are getting out of the lower grade area first met with. The ore developed during the last financial year of the company was valued at nearly 12s. per ton higher than the whole reserves of the mine declared for the previous year. The reserves now in sight are equal to ten years' supply for the present stamping capacity, or at least six years when the additional crushing plant is taken into consideration.

MODDERFONTEIN B.—Additions to the reduction plant to increase the capacity from 45,000 tons to 60,000 tons per month are under construction, nearly the whole of the necessary material having been obtained locally. The high grade which used to be considered abnormal for this property continues, and last year's development added to the average value of the reserves. The easternmost development on the property, which was formerly considered to have the least promise, is now giving satisfactory results. This is of added interest as bearing on the fortunes of Modderfontein East, Limited.

FAR EAST RAND.—This brings me to the general consideration of developments on the Far Eastern Rand. An able memorandum published last year by Mr. Kotz, Engineer to the Ministry of Mines, has had considerable influence on public opinion, and doubtless upon the policy of the Union Government. A Commission was appointed to consider the advisability of State mining, and issued a majority report against the idea, which was adopted by the Government. As regards diamond mining, the Ministry of Mines announced in the House of Assembly that satisfactory arrangements had been come to between the producers for the regulation of prices and for greatly extending the life of the mines. Prior to the deliberations of the Commission the Government had offered two mining leases on the Far Eastern Rand. Our report deals fully with the transaction that resulted from our tender and the subsequent flotation of the Modderfontein East, Limited. Our engineers are now preparing working plans. According to latest advices work can be started with comparatively little expense, and the plant which belonged to the Cloverfield Company will be serviceable. Owing to Treasury regulations we were unable to introduce the shares of the new company on the London market, but they are dealt in on the Johannesburg Stock Exchange, and the premium at which they are quoted is an indication of the favourable reception of the company.

GOLD OUTPUTS.—I will now turn to general matters. The world's output of gold for 1916 was about £95,725,000. The Transvaal contributed £39,485,000, or 41%. The mines under our administration produced £17,000,000, or nearly 18% of the world's production, and provided 51% of the total dividends declared by the mines of the Witwatersrand. Their ore reserve position continues one of strength, and has risen in tonnage and grade over the previous year.

TAXATION.—Recent legislation in the Union of South Africa included some change in the system of taxation. The Legislature adopted this year proposals by the Government framed on a more comprehensive basis than hitherto, and, if I may say so, on somewhat broader lines. The old profits tax and the special War Levy in its present form are to be abandoned. An income tax of 5% is to be imposed—this applies to all companies in the Union, not only to gold mines—further charges being a dividend tax of 7½%, as well as a temporary War Levy of 2½% on the gold mines. The principle of allowing in respect of profits from mining a special reduction by way of amortization is being continued. An excess profits tax is included in the general proposals, but from this the gold-mining companies are exempt. These proposals do not at present throw any additional burden on the gold-mining industry, but it will leave taxation, when the war levy has been abolished, somewhat higher than before the war.

BEWAARPLAATSEN.—The long outstanding question of the disposal of the proceeds of the Bewaarplaatsen has at last been settled. This decision is of considerable importance to our group of mines on account of its preponderating interest in the freehold areas concerned. The funds which have been accumulating for some years arise from agreements made between the Government and mining companies regarding the working of undermining rights. Generally the arrangements stipulate fixed annuities payable by the companies to the Government over varying periods. The total amount of the annuities will exceed £1,750,000. Under the provisions of the Act, and within six months from its commencement, the Government will hand over to the freehold owners $\frac{1}{8}$ths of the amount received to date, and the freeholders' share in the amounts subsequently accruing has been fixed at $\frac{1}{8}$ths. Without definite information on the subject from South Africa, I am unable to give you accurate figures, but may hazard the opinion that to date the companies associated with you are entitled to approximately £350,000, and that about £70,000 annually may be anticipated thereafter from that source for some years to come. During and until six months after the war the Government is entitled to make payment in 5% South African stock.

VENTILATION AND PHTHISIS.—Mechanical ventilation is employed to an increasing extent on the Rand, and is installed in all except one of our mines. There is no doubt that the success which has attended the vigorous campaign against Miners' Phthisis is largely due to its agency and to the ample use of water. It has also been found that the direct introduction of the dry air from the surface to the moist workings in the deep levels is very beneficial in reducing the local rock temperatures. This procedure is confidently expected to play an important part as the depth of the mines increases.

The amended Miners' Phthisis Act, which came into force on August 1, 1916, is a great advance on past Acts, and its provision will be helpful in the sustained efforts to stamp out the disease. The aggregate awards for compensation during the 4½ years from August 1912 to January 1917, were £2,659,412, and the immediate consequences of the Act have been and may continue for a time to be the cause of increased expenditure owing to its retrospective character. But it is safe to say that charges under this head will gradually fall if they do not disappear entirely, as we may hope, with the elimination of the evil. Comparisons between the past and present situation made by the President of the Chamber of Mines in his masterly annual review show what great progress has been made. Out of 3,447 European underground employees examined by the Phthisis Medical Bureau during the last quarter of 1916, a total of 225, or only 6·52%, were found affected by silicosis and tuberculosis, whereas in 1912 the Medical Commission found that among 3,136 men examined no less than 26·1% displayed undoubted signs of silicosis. This is eloquent and welcome testimony to scientific resource and whole-hearted perseverance. Coupled with the provisions for periodical medical examination of persons employed underground, we may expect to see the expulsion of tuberculosis from the mines and the ultimate eradication of silicosis.

The mention of the Chamber of mines impels me to refer to the splendid work done by that body under the presidency of Mr. E. A. Wallers, one of your very active managers in South Africa, in establishing better relations with employees upon whose skill and fidelity the industry depends in every branch of the work. Goodwill between the chief officers, the engineers, the metallurgists and staff, and the men engaged in the active operations is the key note of success. On behalf of the Board I wish to record our great appreciation of their efforts.

COSTS.—Working costs have naturally advanced. The following figures for 1916, taken from the speech of the President of the Chamber of Mines, are self-explanatory:

Increased price of mine supplies, say	£1,750,000
Increased gold realization charges	400,000
War Bonuses to employees	250,000
Allowances to employees on active service	300,000
War levy	500,000
	£3,200,000

Such a sum naturally presses very heavily upon results, but we have the satisfaction of knowing that in times of peace a large proportion, if not the whole of the additional charges will gradually disappear.

STORES.—The amount of stores and materials carried by the mines has been subject to very close supervision. Compared with pre-war standards, considerable increases are shown. We must remember, however, that prior to the war a policy of bringing down stocks to the lowest possible level was adopted, and as a matter of fact the minimum was reached about the time hostilities began. A double object inspired the procedure: economy at the mines and consideration for the local merchants. Large stocks held by individual companies are apt to be wasteful in the accumulation of materials which ever-changing conditions render obsolete. Stocks held by merchants are less subject to this defect on account of their wider connections. Moreover, mining companies have always supported local trade, giving it priority over European or American competition. During the very first few weeks of the war, however, it became evident that the supplies available in South Africa were insufficient to ensure the continuous running of the industry, in consequence of which a buying Committee was established by the Transvaal Chamber of Mines, with which Messrs. A. Moir & Co. were linked in London. The way in which difficulties were surmounted deserves unstinted praise. We are now reaping the benefit of prudent foresight at that time when the question of supply, freightage and insurance had not reached an acute stage. Merchants' stocks could never have coped with the situation. The cost of materials and of freight has risen enormously during the war, hence any comparison between the value of stores held three years ago and now would be obviously misleading. Owing to the greatest economy in consumption and the provision locally of such commodities as it is possible to produce, only 6,000 tons per month are required now by the industry for absolutely essential supplies from overseas.

In connection with local supply, shoes and dies, as well as bar iron, are being made in South Africa, mostly from scrap iron. I should also like to take this opportunity of paying a tribute to the Cape Explosives Factory of the De Beers Consolidated Mines, through whose activity the cost of explosives in South Africa compares very favourably with that ruling in other parts of the world. In spite of all obstacles regular deliveries have been maintained by them and our other contractors. The gold mines have still further reduced their consumption of higher grade explosives in order to free glycerine for war purposes. Another important article which, in dealing with supplies, should be mentioned is cyanide. Its production was at the outbreak of hostilities largely in German hands, but a British company has come forward and succeeded in meeting the demand in spite of difficulties.

About the time of my visit to South Africa last year the members of the Chamber of Mines contemplated taking a direct interest in industrial undertakings deemed worthy of support as factors in the development of the country. At my suggestion a Committee was appointed to study the question with the object rather of giving financial support to approved enterprises than of selecting and sharing responsibility for their management. As the result of the Committee's investigation an industrial development company has been formed with an initial capital of £100,000, subscribed partly by the mining groups and partly by South African banks. I trust this small company may prove useful and be the herald of wider interest in the establishment of manufactories.

OTHER BUSINESS.—With reference to taking over the administration of the Neumann group of mines, the most important units of which are the Consolidated Main Reef Mines and Estate, Limited, the Witwatersrand Deep, Limited, the Wolhuter Gold Mines, Limited, and the Witbank Colliery, Limited, I trust we may be of service to shareholders, and I am sure our new connection in Paris, with the Association Minière, which has recently declared a dividend, will prove a source of mutual benefit when normal times return.

Business in South Africa has been on a fairly large scale, and it is estimated that shares to the value of many million pounds, representing a considerable percentage of the total Witwatersrand capitalization, were imported by the Cape during the year. There is great prosperity in practically all parts of the sub-Continent, and while more speculative counters were formerly in favour, the later tendency has been to invest in sound dividend-paying mining and other companies.

I do not think it necessary to detain you upon the subject of your minor interests. I should, perhaps, single out the Trinidad Oil Company, in which you are interested, for a passing word. The output has now grown to about 6,000 tons per month, and is rising. The quality is good. The Forest Reserve is proved, and the Company's programme, which is an active one, must depend upon considerations which it is too early to discuss to-day.

GENERAL PRINCIPLES.—Leaving current business, may I ask you to bear with me in a few general observations? The past year's operations have permitted the payment of a dividend, the setting aside of a reserve fund, and the carrying forward of a larger sum than that of the previous year. They have, moreover, enabled the Board to follow a conservative policy in the valuation of assets. The wisdom of this course will be readily appreciated when we remember that, owing to previous losses, we are entitled, on the three years' average basis, to allowances of income tax, which in time will be exhausted. Moreover, if we hope to do profitable new business, not exclusively of a banking or investment character, we must be prepared to accept legitimate risk. That element cannot be eliminated from any enterprise in which the prospects of profit are attractive. After the war there should be a good field for the profitable employment of capital. But human foresight cannot pierce the mist of uncertainty that hangs over the future. There are men of standing who seem to think we can approach our stupendous indebtedness with equanimity. They are inclined to make calculations of a very alluring but, I fear, illusory character, as to expunging debt by purchasing land at cheap rates and selling it at many times the cost, or by State control of tropical products with infinitely greater benefits than any private traders have ever yet realized. To take that rosy view, or beguile ourselves with any such specifics, would be to share the fate of all excessive consumers of sedatives.

Let us by all means adopt a bolder policy, including, perhaps, some use of State credit, in the development of latent Imperial resources. The State may justly look for a larger share than hitherto of the profits rendered possible through the opening of unexplored regions by railways, waterways, etc. Undertakings dependent for their success upon enterprise, skill and industry, are, however, more likely to be rapidly developed and efficiently managed by private persons than by a Government Department. That is hardly open to argument, but there is no reason, if great profits arise, why the State should not derive a large share of them. But it is inconceivable that any wealth accruing from such sources can greatly add to the national receipts in any short period of time. The debt will be with us demanding from the outset, for interest and the most modest of sinking funds, a far larger annual sum than was ever raised in any pre-war Budget. And this apart from the necessities of the various Government services. Moreover the borrowing tap, which is the source of our trouble, and the foundation of the false prosperity of the moment, cannot be suddenly shut off with the return of peace. There will be obligations in connection with pensions, demobilisation and restoration of normal conditions that must be met, and some borrowing will still be essential. But a few constricting turns of the tap will shatter the present apparently comfortable financial situation. Prodigality in expenditure we all know has been forced upon us by war. But this does not lessen the effect, and all belligerent powers after the war will find themselves, like individuals, with over-encumbered estates, not knowing where to turn for succour. There is only one remedy—production. And the power to produce will rest upon two main props, credit and the energy of the people. Happily the whole of the wealth dissipated in the struggle will not have been blown into the air. Some of the works established for war purposes will serve the arts of peace. Sulphuric acid, for instance, is the foundation of many industries. Thus the great acid works should be of value, and many huge manufactories now turning out engines of war can be adapted to furnish normal requirements. Moreover the exigencies of war have evolved a great army of skilled men and women which we had neglected to provide in the easy, happy days of yore. I doubt whether any of us yet appreciate the value to the nation of the great army of working women created by the war. Given a general recognition of the fact that the orgy of squandered savings and the accumulation of enormous debt must impose a severe stress on the life of the nation, greater than it has ever faced before, and that the only means of restoring national fortune is through the medium of output, we should all resolve to work as hard as we can and spend as little as our necessities demand. Such reserves as companies like ours may command may be profitably employed. They will unquestionably be heavily taxed. But they will not be readily employed, nor for that matter advantageously employed from the national standpoint, unless they help to build up reproductive industries and provide on the one hand fair earnings for the workers engaged, and, on the other hand, fair returns to the shareholders whose accumulated savings they are. While the title of the worker to fair recompense for his labour is granted, it will be incumbent upon him, if industrial enterprise is to be successful, to give in return hearty effort and his best skill. Some means of averting industrial strife must be found or the strain on the body politic may prove destructive.

The task of creating machinery for the just division of profits between capital and labour should not exceed the wit of man. Its mechanism at first may lack perfection, but experience will expose its defects. Time and patience will cure them. Meanwhile almost any machinery in the extreme situation would be better than none. Finally, as the division of profits is far less important to the nation than the output from which they are derived, all concerned should or, if need be, must bow to the findings of the authority set up for the purpose. Pardon me for this diversion into fundamental considerations. But they bear directly upon the work we are entrusted with, and, as your Chairman, I conceive it right to give you my views.

You will, I am sure, heartily join with me in expressing great sympathy with the disabled, and deep condolence with the relatives of those members of our service who have given their lives in the great struggle which we all hope to see speedily brought to a victorious conclusion. I am sorry to say that Major Schumacher is prevented by his military duties from being present, and I regret that two of our French Directors have also found it impossible to be with us. Vicomte de Breteuil is serving with the French Army and Mr. Octave Homberg, who has been undertaking financial work for the French Government, is unfortunately suffering from the strain of the very important position he has occupied. Mr. Georges Rouliot, in spite of having to face a very inconvenient journey, is, however, I am happy to say, with us today. Before I sit down let me thank your splendid staff and its associates in South Africa in particular, and elsewhere in the world where we have interests, for arduous work ably done during the past year, and to my colleagues and the staff here I tender my hearty appreciation of their untiring support. I beg to move the adoption of the report and accounts.

Mr. Georges Rouliot: I have much pleasure in seconding the resolution.

The Chairman having invited discussion, and no questions having been asked, the motion was put to the meeting and carried unanimously.

Sir Harry Ross Skinner proposed the re-election of Sir Lionel Phillips and Mr. T. J. Milner as directors of the corporation, and Mr. Otto Beit having seconded the motion, it was carried unanimously.

On the motion of Mr. F. J. Dormer, seconded by Mr. Forbes, Messrs. Cooper Brothers & Co. were reappointed auditors of the corporation.

Mr. W. Mosenthal referred in complimentary terms to the work of the past year, and proposed a vote of thanks to the chairman and his colleagues, as well as to the staff, which was seconded by Mr. F. A. Robinson and unanimously agreed to.

The Chairman briefly thanked the meeting, and the proceedings then terminated.

LENA GOLDFIELDS, LIMITED.

Directors : Lord Harris (*Chairman*), A. Wischnegradski (*Vice-Chairman*), Sir Ian Heathcote Amory, F. W. Baker, G. Benenson, Sir Leigh Hoskyns, A. Poutiloff. *Consulting Engineer :* C. W. Purington. *Secretary :* Henry Richards. *Office :* 441 Salisbury House, London, E.C.2. *Formed* 1908. *Capital* issued : £1,405,000. *Business :* Was formed to purchase a controlling interest in the Lenskoie, a Russian company operating gold gravels near Bodaibo, Eastern Siberia ; has recently sold the control to a Russian group.

THE eighth ordinary general meeting was held on June 13 at Salisbury House, London, E.C., Lord Harris (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, said that the reserve accounts showed the following increases : Investment reserve, £464,578, as compared with £423,555 ; dividend equalization, £232,289, as compared with £211,777 ; general reserve, £232,289, as compared with £211,777 ; making a total of £928,156 this year, as compared with £847,110 last year. There were no balances to bring forward, and the result of the operations of the year in Russia and London was to show a balance to credit of £54,951 this year, as compared with £63,940. On the other side, the valuation of the shares held by the company was this year £1,293,706, as compared with £1,397,692 last year, the difference being due to the deduction necessary on account of sales. As regards the transactions with the Lenskoie Company, loans, dividends due, etc., the amount this year was £150,681, as compared with £161,043. Then they were the owners at that date of Russian Treasury bills valued at £972,848, there being nothing under that head last year. Cash at bank and in hand in London and Petrograd was £157,983, as compared with last year £613,871, and the total on that side of the account was £2,278,500, as compared with £2,172,821 last year. As he had pointed out they had £54,951 balance to credit on the year's operations, and had considerable reserve accounts, and yet they had felt it their duty not to recommend the distribution of a dividend, and that had to be justified. Shareholders might fairly say, if it be legitimate for Lenskoie with the sanction of Lena Goldfields, to distribute a dividend, why should Lena not do the same ? The date was of the essence of their reason. If the same condition of affairs had existed last September that existed now he was sure that the decision would have been the same as that now ; but in September last, although they were perfectly aware that the profitable life of the drifting ground was shrinking, and that there probably would be a serious falling off in receipts of Lenskoie as between the reduction of work on drifting and the commencement of work with a dredge, still there were at that time, so far as they could see, no reasons why Lenskoie should not distribute a part of the profits it had made. But a great deal had happened since the spring of this year. Up till the introduction of the political changes which commenced in Petrograd in the spring they had every reason to anticipate a net profit of some three million roubles for the current year, which would have been available for dividends, but they had been warned that it would be necessary to make such increases in pay at the mines as would so materially reduce the available profits of the year as to render the future very dark. It was to some extent affected by what price the Lenskoie Company might receive for the gold it produced. During the past year gold was permitted to be sold at a considerable premium to the traders that used that metal. That had since been stopped. It was possible, however, that a premium might still be permitted on gold sold, and that would affect the accounts of the year beneficially, but it was an uncertain factor ; but there was the inevitable adverse factor, when the price of gold came down, that all foodstuffs, stores and supplies which had been purchased at high prices now stood at a high figure in the books. At the present moment the Lenskoie Company was in the situation of having book profits but empty pockets. Upon all the gold deposited at the banks in Petrograd loans had been contracted in advance, while the Lenskoie owed this company between two and three million roubles. The difficulty did not end there. There must be an inevitable drop in the receipts of Lenskoie when the rich drifting ground was worked out and before the first dredge began to work, and in addition to that they were also warned that the Lenskoie Board thought it would be politic to order another dredge now. The Lena Board was going into that question, and before they decided they would endeavour to get further technical evidence as to the prospects of the dredging ground. If the information they got justified it they would then have to consider the cost of adding the second dredge, and the expense would not be confined to the dredge itself. That at present prices would cost about £300,000 delivered in the field, but the power at present in existence was not sufficient for more than one dredge, and it would be necessary to increase the power plant at a cost, it was estimated, of some £200,000 more. Therefore, for the two dredges and the power plant there was an expenditure hanging over Lenskoie of some £800,000. Possibly other methods of obtaining these funds if they were decided upon might present themselves, but failing other methods, then it seemed to them inevitable that this company would be called upon to find a considerable proportion of the amount. That they would very possibly be able to do owing to sales they had made ; but having regard for these financial difficulties that were ahead, for the very uncertain position that the Lenskoie Company was in as regards costs of production, and for the generally unsettled state of affairs, they had taken the step of asking shareholders to forgo a dividend this year.

The next important subject was the policy that had been pursued by the three directors who signed the memorandum attached to the report. They had endeavoured to give as full an account of the transactions referred to as possible. Their Excellencies who opposed this deal had also caused a memorandum to be circulated. He thought the directors were justified in claiming that the events which had taken place since that action was taken had put the transactions described in a still more favourable aspect than was the case at the date of the transactions, and in a more favourable light than could possibly have been anticipated then. Mr. Benenson, who with Sir Ian Heathcote Amory represented on the Board the powerful group who had purchased the shares, had gone to Russia. His presence in Petrograd would, they hoped, lead to results entirely favourable to the company.

Mr. F. W. Baker seconded the motion, and after some discussion, initiated by Mr. Inchbald relating to the deal in Lenskoie shares, the motion was carried unanimously.

MONGU (NIGERIA) TIN MINES, LIMITED.

Directors : W. F. Turner (*Chairman*), Sir Edwin H. Dunning, Sir Robert Hampson, Oliver Wethered. *Secretary :* A. W. Berry. *Office :* 22 Austin Friars, London, E.C. *Formed* 1914. *Capital* issued : £115,153, in shares of 10s. each.

Business : Operates alluvial tin ground in Nigeria ; has recently purchased a dredge from the Benue company.

THE third ordinary general meeting of shareholders was held at Winchester House, London, E.C., on June18, Mr. W. F. Turner, Chairman of the company, presiding.

The Secretary, Mr. Alfred W. Berry, having read the notice convening the meeting and the report of the auditor,

The Chairman said : We submit to you to-day the third annual directors' report and statement of accounts, which are made up to December 31, 1916. The facts with which we have to deal are few, but they are, I think, both interesting and satisfactory. The share capital has been increased during the year by the issue of 15,000 shares at par—that is, £7,500—for working capital, and the issued capital now stands at £115,153. 10s. 0d. We propose to declare, to-day, a balance dividend of 10%, free of income tax, payable on June 19 instant. This makes, with the interim dividend of 5% paid on November 23 last, also free of income tax, a total dividend for the year of 15%, free of tax. I want to emphasize the fact that these dividends are paid free of tax, because, as I had occasion to say recently at the meeting of another company, it is found that people are apt to overlook the difference between a tax-free dividend and a dividend from which tax is deducted. Nevertheless, it is plain enough that on the basis of the present rate of income tax—5s. in the £1—a dividend of 15%, free of tax, is exactly the same thing as a dividend of 20%, subject to tax, and you must keep that in mind when comparing our dividends with those of other similar concerns. The profit and loss account, including the sum of £3,801 brought forward from the preceding year, shows a credit balance of £21,566. This is after writing off £100 donation to the Nigeria War Fund, which was voted at the last general meeting, £199 for preliminary expenses, £800 proportion of expenditure in prospecting the property up to December 31, 1914, and £710 for depreciation.

I need not go through the profit and loss account item by item, but there is one point, and that a very important one, to which I must draw your attention. It relates to the valuation of the tin concentrate in stock or in transit at December 31, 1916, which amounted to 285 tons. Now the practice of most, if not all, of the Nigerian companies is to take the stock of tin into the balance sheet either at the market price of the date of the balance sheet or at the price which has subsequently been realized. The effect in each case is to take credit in the profit and loss account and in the balance sheet for approximately the realizable value of the tin on hand at the end of the year. This is not our practice. The stock of 285 tons in transit or on hand at December 31 last has been taken into the profit and loss account and into the balance sheet at cost price, the cost price being ascertained by taking the whole of the debits in the profit and loss account and dividing the total by the output for the year, the value arrived at in this way being £18,541. About 184 tons of this stock has been realized, the remainder has left the mine, but much of it is still on the water. If we were to take the stock into the profit and loss account at the price realized for that portion which has arrived, and at about to-day's price for the portion which has yet to be realized (101 tons), the value would amount to about £15,000 more than the figure in the accounts which are before you, which would be equal to a dividend of about 13%. This is, no doubt, a very conservative basis to adopt, and a sound one. It practically creates a reserve against anything of an adverse character which might arise during the present year, although, so far, nothing adverse has arisen. As a matter of finance it is obviously a right method, because we only get the benefit of the stock as and when it is realized.

There is little to be said as regards the balance sheet. The creditors amount to £6,470, which is about £1,700 less than the year before. The cash at bankers, £8,464, is about £1,000 in excess of the previous year. The tin concentrate in stock and in transit, £18,541, would stand at nearly £34,000 if valued in the manner to which I have just referred. The dredge account, £4,460, I shall explain presently. Stores, £4,923, show an increase of about £1,500. The next item, preliminary expenses £199, will disappear in the current year's accounts and the balance of expenditure to December 31, 1914, £4,004, will be materially reduced. The balance to the credit of profit and loss on the other side of the balance sheet is £15,808. This will be reduced by the dividend to £4,293, to be carried forward, subject to provision for income tax.

The report states that four Mining Rights have been granted or applied for on creeks which are tributaries of the Mongu River. We have, however, since received advice by mail that an area of about four square miles has been taken up under Exclusive Prospecting Licence and that a Mining Right one mile in length on a certain creek has also been applied for, and we hope that substantial results will be obtained from these combined sources. The output of tin concentrate since the formation of the company has been as follows: During the 10 months to December 31, 1914, when we were engaged in prospecting and developing the property we won incidentally 186 tons. For the year 1915 the output was 490 tons. For the past year, 1916, the output was 576 tons. The output of dressed tin concentrate was 557 tons, the difference of 19 tons being accounted for by the tin left in the tailing, which will be treated in the current year. The "all in" cost of the output in Nigeria, including the royalty, was in round figures £57. 11s. 0d. per ton. The average selling price of the tin concentrate realized during the year was £123 per ton, whilst after deducting rail and ocean freight, returning charges, etc., which come out of the proceeds of tin sales, the average price realized was £95 per ton.

I now come to the subject of the dredge, which is the feature of the year. Ever since the formation of the company the directors have given a good deal of consideration to the question of the best means of dealing with the company's principal area, which is known as No. 9 Block. This block adjoins the Ropp Co.'s property, and the River Mongu, which rises in that property, runs into ours at this point and continues through our property for a distance of about 12 miles. We took expert advice on this subject nearly two years ago, which was to the effect that the tin deposits in No. 9 Block could only be worked by means of a dredge, and that certain other areas should also be worked by dredging. The cost of the proposed dredge was far beyond our means, and in view of the difficulty of raising a large amount of working capital during the war and the difficulty of obtaining plant and machinery, it was decided not to undertake dredging so long as a satisfactory and economical output could be obtained by other means from other parts of the property. That was the effect of the statement made in the last directors' report. In the month of August last, however, we had the opportunity of buying at a satisfactory price a dredge of the right type as it stood on the property of the Benue Company in Nigeria. We obtained a short option of purchase, which gave us just sufficient time to have the dredge carefully inspected, and also, what was equally important, to inspect the sister dredge built by the same makers, which was in operation on the property of the Jos Tin Area. The main fact of the situation was that while the dredge was not suitable for the Benue Company's ground, the one at the Jos property was treating quite satisfactorily, both as regards extraction and working cost, ground which was as nearly as possible of the same character as that with which we have to deal in our No. 9 Block. We exercised our option of purchase. We had the good fortune at the same time to engage in London a competent dredge master and three good mechanics, who left immediately for Nigeria, followed by our manager, who was then at home. By the end of December the dredge had been dismantled and transported from the Benue mine to the railway and delivered at railhead at Bukuru. Special arrangements had to be made to ensure the transport of the dredge from Bukuru to the mine and to get as far forward as possible with the erection before the coming of the rainy season. We have received a cablegram stating that the trial running of the dredge will take place in about a week's time. The continuous running is dependent on the arrival of certain stores and spares, which have been ordered and shipped, but which at the date of our cablegram had not reached the mine. I must give a word of praise to our manager, Mr. Powis, for the energy and resource which he has shown in this matter, and to his assistants for the work that they have done. The estimated capacity of the dredge is about 20 tons per month, say 240 tons per year. If we add to this the output for the year 1916, we arrive at a total output capacity of about 800 tons per year, and as the ground with which we have to deal in No. 9 Block is richer than most of that which we have been treating hitherto, it follows that we are to-day in a better position in regard to output and to profit earning than we have ever been hitherto, and I think we may congratulate ourselves on the position to which we have attained in little more than three years since the formation of the company.

The remaining subject, and I suppose the most interesting one, is the prospect for the current year. I have just told you what is in round figures our output capacity, assuming, of course, a reasonable supply of labour such as we have had hitherto. The report tells you that the output for the first five months of this year amounted to 258 tons as compared with 250 tons in the corresponding period of the preceding year. These two factors are satisfactory, and as you all know, the third factor—the price of tin—is also satisfactory, more so than at any time during the company's existence. We are therefore manifestly in a position to earn much larger profits this year than those of 1916, but as soon as one utters such words the shadow of the excess profits duty falls upon one. I cannot escape the subject, unfortunately, but I am not going to dwell upon it ; it has been threshed out so fully in the press and at meetings of companies of all kinds that we are all getting tired of it. I noticed the other day that at the meeting of a rubber company the chairman stated that every influence had been brought to bear upon the Chancellor of the Exchequer short of personal violence, and for my part I think we have got to make up our minds that the 80% will stand, and that it will date, as is proposed, from January 1 last. There is no denying the fact that the tax is particularly hard on the Nigerian tin mining industry, which deals solely with alluvial deposits. I forbear to make any comparisons between the case of Nigeria and that of the Rhodesian gold industry, where a 22½% standard has been allowed as against 13% for Nigerian tin companies, or with any other industry which from whatever cause has received more favourable consideration. All I say is that the tax is so heavy, and its incidence in our case so unjust, that it compels us as directors to weigh carefully the interests of the shareholders in settling the policy to be adopted for the time being. Having regard to the question of the life of Nigerian mines, I can find no justification for working our property on such a scale as to expose us to a heavy liability for excess profit duty. The effects of so doing would be to take away what would be not a real profit, but a proportion of the capital of the shareholders, and pay it over to the Government under the name of Excess Profits Duty. Under these circumstances you must not look for any increase in the company's output during the present year as compared with the year 1916. No increase will be necessary. It will have been clear to you from what I said earlier in this address, when dealing with the profit and loss accounts, that there will be no difficuty in earning a 20% dividend in respect of the present year. How much further than that we should go is a matter that will require consideration, and also some arithmetical calculation. If all goes well with the dredge, we shall have to run it continuously, for the reason that it requires a special staff of skilled men who are on the spot, and it cannot be run intermittently. If the dredge produces the output which we confidently anticipate, we shall be able to diminish the output which is obtained from other parts of the property by the ordinary means. If the price of tin should fall materially, which we do not expect, we shall be in a position to meet that by increasing the output. If the price of tin should rise materially, we can afford to reduce the output. In one word, the matter will have to be left to the discretion of the board to be dealt with according to circumstances. The probabilities are, however, that the output for this year will be less, and that at the same time the profits will be more. I move : "That the directors' report and accounts be received and adopted, and that a dividend of 10 per cent., free of income tax, making 15 per cent., free of income tax, for the year, be and is hereby declared."

Sir Edwin H. Dunning seconded the resolution and it was carried unanimously.

The Chairman : I have now great pleasure in moving that the retiring director, Sir Robert Hampson, be and is hereby re-elected. Sir Robert Hampson, in consequence of ill health, due to an accident, has felt it his duty to resign his position as chairman of the board. I am glad to say, however, that he is making a very good recovery and that we shall not, we believe, be deprived of his assistance and co operation very long.

The resolution was seconded by Mr. Oliver Wethered and unanimously agreed to.

On the motion of Mr. Weston, seconded by Mr. Royston, the auditor, Mr. Ralph M. Everett, was reappointed.

The proceedings terminated with a vote of thanks to the chairman.

BISICHI TIN COMPANY (NIGERIA), LIMITED.

Directors: James Gardiner (*Chairman*), William Graham, W. S. Coutts. *Managing Engineers:* Laws, Rumbold & Co. *Secretary:* H. J. Barrow. *Office:* 33 Cornhill, London, E.C. *Formed* 1910. *Capital:* £200,000.

Business: Operates alluvial tin properties in Nigeria.

THE sixth annual general meeting was held on June 13 at the Cannon Street Hotel, London, E.C., Mr. James Gardiner (the Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that at the date of presentation of the accounts last year, out of a total production of 310 tons, only 10 tons remained to be sold. This was realized at about the figure at which the ore had been taken into the statement, and the average of the year's output stood at £130. 8s. per ton of ore, equivalent to £179 for metallic tin. On the present occasion, owing to causes beyond their control connected with transport and freight tonnage, etc., due to war conditions, they had marketed only two-thirds of the production at the date of the report. This quantity, however, realized an average of £136. 5s. 2d. per ton, the equivalent of £187. 17s. 4d. for metallic tin. Not only was this an improved return, but the latter figure compared favourably with the market average of £182 for the year 1916. Since the opening of the current year the advance in the price of tin had been steady, and they had had the advantage of the higher level in the realization of part of the ore, and their further sales had been made at a little above the price estimated in the accounts, the average for the ore being raised thereby to £148. 5s. 3d., while they still had 61 tons to dispose of. Taking the accounts as whole, they made a satisfactory showing, resulting as they did in very favourable realizations of the production at a reduced working cost, for, including a higher scale of royalties and insurance, the "all-in" cost of the ore stood at £89. 3s. 8d. per ton as compared with £96. 14s. 11d. per ton for 1915. In the property they had a valuable asset. The plant, etc., had been written down to a low figure. They had an investment in another mining property which should very shortly give satisfactory returns, but irrespective of these they had tangible and liquid funds in War stock, Treasury bills and deposits at bank, which, with the stock of tin unrealized, amounted to £56,000. After making allowance for the payment of the dividend recommended they had the substantial sum of £31,000 at their disposal as working capital. This was a comfortable assurance in present times.

On the last occasion when he addressed them he mentioned that under representations made by the Chamber of Mines, the Government had agreed to establish a flat rate on all tin ore carried by rail, and they were now reaping the advantage of that arrangement. Unfortunately, however, they had a set off to this under the head of royalties, which were worked under the sliding scale system, and which, on the basis of existing prices, would make a substantial addition to the costs. On the other hand, shipping rates had remained unchanged, a point which spoke favourably for the policy of Messrs. Elder, Dempster & Co. in the present circumstances, when so much was heard, and not without cause, on the subject of profiteering.

As regards the other factors which influenced the working of the property, namely, European staff and native labour, the replacement and relief of the former was a serious problem which had been under the anxious consideration of the directors for some time past. Of the partners in Messrs. Laws, Rumbold & Co., who had acted as their managing engineers under an agreement with the Niger Company, Major Laws, D.S.O., as he was now, had been serving with distinction since the outbreak of war. Mr. Rumbold, on his return from Nigeria early last year, obtained a commission and was now with the forces in East Africa. Mr. Johnson, of this firm, had been out in Nigeria, and had done good service, considering that he had had to supervise other properties as well as theirs, and in addition the various mining interests of the Niger Company, by whom their services were placed at their disposal. In the circumstances, and in view of the fact that they had practically no margin of relief in regard to their European establishment, they had arrived at a working arrangement with the Forum River Company, their near neighbours, whereby Mr. Arthur W. Hooke, who had been their managing engineer for over four years, acted in the same capacity for Bisichi, and they had had the advantage of his services since the beginning of this year. The staffs of the two companies would be interchangeable, and would afford a greater margin of safety and efficiency than they could hope to maintain otherwise. Mr. Hooke's administration of the Forum property had been not only satisfactory but eminently successful. As Chairman of the Forum River Company as well as Bisichi he could speak on this point with some assurance. This new arrangement would maintain continuity of policy, would consolidate the working, and, owing to the reciprocal movements of the assistant engineers, by familiarizing them with the conditions on both properties, would facilitate the general management.

The working arrangements for the current year were laid out well in advance, and had developed satisfactorily. It was confidently expected that the production for the first six months would be maintained at the average of last year. The centralized positions comprised in last year's work had facilitated supervision and rendered the task of management on a reduced staff less difficult, but there had been little margin to spare in prospecting. A certain amount of work had been and was being done on the central flat. A mining right had been taken over 1,700 yards on E.P.L. 749, and a further 900 yards had been more recently pegged out on the Fusa River, adjacent to lease "E.N." As he had already said, they had a valuable asset in their property. Their ore reserves were extensive, and they were finding good ore on high ground, where not expected. They had a valuable asset in their water supply, which enabled them with their hydraulic plant to work low-grade areas profitably and systematically with the richer deposits. The directors were fully alive to the importance of adding to their reserves by securing further areas, and plans for operations had been laid for some time past, but there was a difficulty in providing the necessary prospecting staff under existing war conditions.

Mr. W. S. Coutts seconded the motion, and it was carried unanimously.

NARAGUTA EXTENDED (NIGERIA) TIN MINES, LTD.

Directors: S. R. Bastard *(Chairman)*, Sir George C. Denton, H. C. Godfray, John Waddington. *Consulting Engineers:* C. G. Lush & Son, London; R. W. Hannam, Nigeria. *Secretary:* A. J. Culley. *Office:* Friars House, New Broad St., London, E.C. *Formed* 1911. *Capital* issued: £152,757.
Business: Operates alluvial tin properties at Naraguta, Nigeria.

THE fifth ordinary general meeting was held on June 13 at Winchester House, London, E.C., Mr. Segar R. Bastard (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, turned first to the balance sheet. As regards the first item, sundry creditors, £3,444. 7s. 6d., in this item was included two amounts, one the amount payable in respect of the pipeline purchased from the Lucky Chance and the other the balance due on the pipeline purchased in America. The rest of the item was made up of the usual charges of rent and royalties for which they were indebted to the Niger Company. The whole of these amounts had since been settled. The next item was bills payable, £5,000. This was the balance of a sum of £10,000 which the Niger Company some two years ago accepted in bills. In reference to this, they had purchased £5,000 War Loan which they had allocated to meet the demands of the Niger Company as they became due. The first became due next September and the second in the following March. On the assets side, there was the large item of £15,334 for plant and machinery stores. This amount was incurred in the early years of their existence, and until last year, when they made a profit, they had not been able to write any of it off. Nothing, however, had been added to the amount during the period covered by these accounts and it was exactly the same as it was in 1916. They had also written off 10%, the amount allowed by the Inland Revenue authorities, and the item of preliminary expenses disappeared from the balance sheet, as they had paid off the balance of £1,246. The item of buildings and surface work, £3,887. 12s. 2d., had been written down by 10%, the amount they were allowed to write off. In the profit and loss account, the total amount realized for tin concentrate was put down at £36,620. 10s. 11d. Owing to the time it took to realize their tin concentrates, from delay in transit and the time the smelters took before they paid them, it was a difficult matter to arrive at that figure with absolute exactitude. He was sure that it would prove to be a conservative figure.

Considering the times in which they were living, a wonderful change had taken place in the fortunes of the company, and they might congratulate themselves on their position. Last year a shareholder ventured to remark that he thought the company should be able to pay a dividend this year. At the time he (the Chairman) said he did not think so, but he had proved to be wrong. The output increased by 83 tons over 1916 and the average price realized had also increased. In regard to the expenditure in Nigeria, they had taken the proper course and had written off every kind of expenditure out of revenue. They spent a considerable sum in building leats, bridges, houses, and making roads, all out of revenue, so that the profit had really been quite considerable, and had the balance sheet been prepared in a different way they could have made the result look much better. From Mr. Hawkes' report they would have noticed that they had taken up two additional leases. These were covered by the exclusive prospecting licences, and he considered they had got the cream of all that was included in those licences. Outside what they had got there was nothing that was worth very much. A letter from the other side, received a day or two ago, reported that a further mining right had been pegged. That was more in the nature of a precautionary measure, to prevent others coming there, than with the idea of getting more tin.

Mr. Hawkes' report was a short one, but very much to the point. The new people they had put in since Mr. Hawkes resigned had reported that they were thoroughly satisfied with the property. The retirement of Mr. Hawkes from their service was a matter of very great regret to the directors after the splendid services he had rendered them. The board did everything they could to retain him and offered to meet him as regarded salary if he would stay, but he had made arrangements to work other properties and could not accede to their request, preferring to go and work on his own account in conjunction with his brother. They had installed Mr. Cook, who was well experienced in sluicing and hydraulic work. He did not think they were going to suffer very much by reason of Mr. Hawkes having left them. He wanted to say, in favour of Mr. Hawkes, that he did not, as those employed by other companies had done when they took up properties for themselves, take away his headman and other men, which he readily could have done, but had loyally allowed them to remain on the property, with the result that the output had not suffered. Since Mr. Hawkes wrote his report a letter had been received from him in which he suggested, and indeed recommended, that the time had come for the installation of a big pipeline on the property, and he recommended that they should send their big pipeline, which they had already purchased and paid for in America, to Nigeria. The board thought that as Mr. Hawkes had left the management of the company it was only due to his successor, who was now consulting engineer, to ask his opinion. The cost of transporting this pipeline to Jos from America would be very heavy and the Government would not help them with regard to railway rates. Their charges, as he had always said, were iniquitous. They calculated roughly it would cost £3,000 and would take some time to do. They would be prepared, whenever an opportunity offered, if Mr. Hannam recommended this course—and he probably would—to undertake the work and they would get it done as cheaply as possible. This property would certainly require to be worked by a pipeline, but in the meantime they would not suffer, because they had a pipeline bought which had already come into service and he trusted they would see results before long. Therefore, there was no immediate hurry, and they need not fear any falling off in the returns in the meantime. Mr. Hawkes anticipated an increase in the output in 1917 over 1916. Although Mr. Hawkes, from the causes explained, had been unable to give much personal attention to working the property, up to the end of May the output had increased by 20 tons over 1916.

There was one other matter that required mention and that was the advent of a new bank into Nigeria to compete with the Bank of British West Africa. They remitted from £700 to £1,000 a month and the charges were 3% on the gross amount and in addition ⅛% on the turnover, together with cable charges for remitting the money. The Colonial Bank had now given them a rate of 2¼% and cable charges, and had agreed to make only the nominal charge of £5 a year for keeping the accounts. That was a step in the right direction and other changes would no doubt follow to their advantage.

Sir George C. Denton, K.C.M.G., seconded the motion, which was carried unanimously.

On the motion of the Chairman, seconded by Mr. G. E. Buling, a dividend at the rate of 5% less income tax was declared payable on June 18.

The Chairman proposed the re-election as a director of Sir George C. Denton, and the motion was seconded by Mr. Waddington and carried unanimously.

Mr. Michaels moved the re-election of the auditors, Messrs. Newman Ogle Son and Grace, and the motion was seconded by Mr. Buling and carried unanimously.

The proceedings terminated with a vote of thanks to the Chairman, directors and the staff, both in Nigeria and London.

ST. JOHN DEL REY MINING CO., LIMITED.

Directors: H. Percy Harris, M.P. *(Chairman)*, Sir J. F. Remnant, M.P., Sir Edward Goulding, M.P., Col. H. Le Roy-Lewis, C. F. W. Kup (*Managing Director*). *Superintendent at Mines:* George Chalmers. *Acting Secretary:* F. V. Steward. *Office:* Finsbury House, London, E.C.2. *Formed* 1830, reconstructed in 1887 and 1888. *Capital* issued: £546,265 in ordinary shares of £1 each, and £100,000 in 10% preference shares of £1 each. *Business:* Works the Morro Velho gold mine, in Minas Geraes, Brazil; also owns iron, manganese, and bauxite deposits.

THE annual general meeting was held on June 28 at the Cannon Street Hotel, London, E.C., Mr. H. Percy Harris, M.P. (the Chairman), presiding.

The Managing Director (Mr. C. F. W. Kup) having read the notice convening the meeting and the auditors' report,

The Chairman said that the results of the past year were very similar to those of the preceding year, the profit amounting to £155,593, as compared with £159,076. They had every reason to be satisfied with that result. It was due to the excellent quality of the ore which was now being produced from the mine. His only regret was that the company was not able to derive the full benefit from the improved ore because of the excess profits tax and for other reasons arising out of the war. The dividend would be the usual 10% for the year if the shareholders adopted the Board's recommendation. The result of their self-denying ordinance in the past was that the company was in a strong financial position, and they were able to face the present crisis with a degree of confidence which would not have been possible without the careful financial policy of the past. With regard to the mine, Mr. Chalmers stated in his report that a change had undoubtedly taken place in the lower horizons, which seemed favourable both as regarded the quality of the ore and also as to the size of the lode as shown by its horizontal sectional area. That change for the better appeared to be a feature of the two lowest horizons, and was borne out, first, by the yield of the ore, which was the highest recorded since the re-opening of the mine, and, secondly, by the increase in the tonnage per vertical foot, which was 1,127 last year, compared with 977 in the preceding year. It must be observed, however, that the increase in the tonnage per vertical foot might be due, to some extent, to the flattening of the lode. Then there had been a satisfactory increase in the reserves of ore. It was estimated that there were 935 vertical feet of ore standing at the mine on February 28 last, as compared with 807 vertical feet in the preceding year. Those 935 ft. ought to give them just about the 1,000,000 tons of reserves which they had had for a good many years in the past.

There were three matters rather outside the ordinary run of their work to which he wished to refer. The first was that the Board had authorized explorations on a river at a considerable distance from the mine with a view to dredging if results were satisfactory. The next matter was one of importance. It was the discovery of a large belt of manganese on the company's property. At one time the company had no money to spare for the purpose of exploring the vast territory which it possessed, but in recent years they had been able to spend some money for this purpose, and the present discovery was one of the results. He could not hold any hope that immediate use could be made of the discovery, because the railway facilities for dealing with manganese were not available, but it did constitute what they might hope would be a valuable asset in the future. Another matter was the planting of eucalyptus and wood distillation. The object of planting these trees was, in the first place, to provide the company with the charcoal and firewood and timber which it needed, and which was becoming more difficult to obtain as the forests near the mine disappeared. This was an important question not only for the company's immediate purposes, but also because the economical production of charcoal on a large scale would enable them to work profitably their iron lands, a subject which was never absent from the directors' thoughts. In conclusion, he moved the adoption of the report and accounts.

Sir James Remnant, Bart., M.P., seconded the motion, and it was unanimously agreed to.

SIAMESE TIN SYNDICATE, LIMITED.

Directors: Cyril K. Butler (*Chairman*), Sir James Heath, T. Gilbert Scott, W. H. P. Stevens. *General Manager:* H. G. Scott. *Secretary:* C. A. Underwood. *Office:* Capel House, New Broad St., London, E.C. *Formed* 1906. *Capital* issued: £120,000.

Business: Works alluvial tin deposits by bucket-dredges in the Renong district, Western Siamese States.

THE tenth ordinary general meeting was held on June 19 at Winchester House, London, E.C., Mr. Cyril K. Butler (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that the gross receipts from the sale of ore amounted to £106,236. The total cost, including working charges, repairs and renewals, marketing, duty, and all management expenses in Siam, was £62,277, or only 58·62% of the gross receipts. After charging the £2,418 spent on the upkeep of the coconut plantations, there remained the sum of £41,540 to be carried to the profit and loss account. After adding sundry items of interest and fees and after charging London expenses and directors' fees and writing off £10,810 for depreciation, they were able to carry to the balance sheet a balance of profit amounting to £27,908. The details of the sum charged for depreciation were set out on the credit side of the balance sheet and the directors were satisfied that ample provision had been made, with special regard to existing conditions and to the prospective life of the Ngow property.

The report of the general manager gave in detail the working of each dredge on the Ngow property, and told the position with regard to the company's other interests in Siam. It mentioned some of the difficulties that had to be met in the conditions arising out of the war. It was wonderful how, under the infectious enthusiasm of Mr. Wakefield and his lieutenants, the capacity of the workshops and foundry had been made to expand so as to off-set to a marked degree the delays and loss involved in the sending out of the necessary parts for repairs and renewals of the machinery from England. Much excellent work had been done by their secretary, their purchasing agents, their shipping agents, and all concerned on this side in getting such materials manufactured and dispatched; but all their requirements were of a kind that could only be manufactured and supplied under permit from the Ministry of Munitions, and could only be exported from this country by license of the War Trade Department. The needs of the country for the purposes of the war were paramount, and they must not complain if they had to bear their share of the disabilities attaching to such a state of things. All the more were they indebted to their engineers and dredge masters at Ngow, who, in the true spirit of the times, were not only willing, but able to make substitutes do where the real article could not be obtained, and, with the genius born of necessity, made with barely sufficient plant highly efficient repairs and renewals as circumstances demanded. It would be idle to suggest that they were so equipped at Ngow with adaptable brains and materials as to eliminate risk of delays or even stoppage through possible breakdown. At any moment the need might arise for the replacement of some vital part of one of the dredges, which could not be replaced from here and for which the quick intelligence of the engineers at Ngow was unable to provide even a temporary makeshift.

With regard to future possibilities, it was common knowledge that this company was not to be regarded as an operating mining company pure and simple, to acquire, prove, work out, and ultimately abandon a single mining property such as the property at Ngow. Rather was it to be regarded as at once a mining and a prospecting company, and it had been the consistent policy of the board to favour prospecting and sufficient development work on promising ground so as to ensure continuity of activity as properties passed their maximum productiveness, and an extension of activity when the restoration of normal conditions made it possible to provide the necessary plant and machinery. The conditions arising out of the war, however, made it imperative that the general manager should devote a great deal of his personal attention to the actual carrying on of mining operations at Ngow. The manager and others of the white staff at Ngow came home to join the Army, and it was some time before everything could be arranged so that Mr. Wakefield could take over the full responsibility for the operations on that property. During the transition period prospecting had necessarily to be considerably curtailed. In the last few months however, the general manager had been free to take up more outside work, and he had resumed with great activity the investigation of promising prospects. He had a number of likely areas in view, and within the last month they have heard from him that he had obtained encouraging results on a certain property in the Malay Peninsula and that he had now set two parties to work to bore it thoroughly to prove its extent. The other properties in which they were already interested had not as yet become producers, as was noted in the general manager's report, but when normal times returned and they could once more obtain the plant, machinery, and skilled assistance to develop them, they believed that they would see them yielding fine returns. Of the staff who were in the service of the company in Siam at the beginning of the war, Mr. Wall, Mr. Adeney, and Mr. Skinner now hold commissions in His Majesty's Army, and Mr. Wall had proved his worth by winning the Military Cross. Mr. Weir had also come home and had now joined up, as had also their secretary's brother, who formerly bore a large share of the work of the London office, and whose absence threw a great deal more work on the secretary himself. The directors had reminded shareholders in their report of the interim dividends paid in July and November last, and had told how they proposed to deal with the balance at the credit of the profit and loss account by payment of a final dividend of 5%, making 25% for the year, and by carrying forward the balance of £2,116 to next year.

Mr. T. Gilbert Scott seconded the motion.

Mr. Birch asked whether the Chairman could give any particulars with regard to the Bandon mine.

The Chairman, in reply, said that there was an explanation of the present position of the Bandon mine in the general manager's report. The subsequent reports which had been received were satisfactory, and he hoped that the mine would be producing very shortly; in fact, he would not be surprised to hear that they were winning ore from it in the course of the next month.

The motion was carried unanimously.

TEKKA, LIMITED.

Directors : James Wickett (*Chairman*), F. Douglas Osborne, W. R. H. Chappel, S. Howard Lanyon, Harry Rich. *Secretary :* Tom Wickett. *Office* : Redruth. *Formed* 1907. *Capital* issued : £80,000.

Business : Operates an alluvial tin property in Perak, Federated Malay States ; has a holding in the Tekka-Taiping.

THE tenth annual meeting was held at Redruth on June 27, Mr. James Wickett, Chairman of the company, presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended January 31 last, said that the returns had increased from 400 tons to 491, and the value had increased by £12,615. The prospects at the mine were very encouraging. During the year they had expended a good sum of money in order to comply with the Government regulations with reference to tailings. The profits for the year had enabled the directors to pay four dividends of 1s. 6d. each, and it was proposed to pay a fifth to-morrow, and to materially increase the balance carried forward. This was a company in which the anticipations of the promoters had been realized beyond the most sanguine hopes.

Mr. S. Howard Lanyon seconded the motion.

Mr. W. R. H. Chappel, one of the managers, said that the output was 491 tons, which was an increase on the previous year of 90 tons. The cause of this increase, in the first place, was the larger yardage treated, and, in addition, the value of the ground treated showed an increase in recovery in 0·1 catty per cubic yard. Then, fortunately, during the past year they had no long period of shortage of water. As regards working costs, these showed a reduction on last year—again due to increased yardage—of about 13%, as compared with the previous year. He was hopeful that these working costs might still be brought down. He anticipated a decrease of cost of upkeep of tailing dams because during the past four or five years a considerable proportion of the output had come from the first paddock, where they had to use elevation for the recovery of tin. At the time the annual report was written that paddock was practically worked out as far as they could work it economically with the water at their disposal. In order to make a clean sweep of all the tin, and of any tin lying in the bottom of the paddock between the pinnacles of limestone, they had parties of tributers working there. This work would soon be completed, and then they would dump the tailing into the old paddock from the new paddock which they had opened during the last few months. As regards the new area of 38 acres, this was contiguous to the original blocks belonging to Tekka, Ltd. and, formed a salient into their original blocks, owing to these 38 acres being composed of small blocks which were cut and given out by Government before this company was formed. The result of their getting control of these 38 acres would enable them to work their own land and this land more efficiently and economically. It would probably be necessary to alter the position of the pipeline. This was due to the proximity of some of the working faces to the original position of the pipeline. They would have to relay a comparatively short length of pipe where it crossed the mining leases.

The motion to adopt the report and accounts was carried unanimously.

OURO PRETO GOLD MINES OF BRAZIL, LTD.

Directors : John Taylor (*Chairman*), E. Beer, M. Paisant, E. de Wael, Robert Taylor. *Honorary Director :* Baron Oberkampf. *Managers :* John Taylor & Sons. *Secretary :* G. H. Wells. *Office :* 6 Queen Street Place, London, E.C.4. *Formed* 1884, reconstructed 1893, and 1914. *Capital* issued : £39,429 in ordinary shares, and £12,212 in preference shares, both of £1 each.

Business : Works the Passagem gold mine in the State of Minas Geraes, Brazil.

THE third ordinary general meeting was held on June 27 at No. 6 Queen Street Place, London, E.C., Mr. Robert Taylor presiding.

The Chairman, in moving the adoption of the report and accounts, said that the results of the year's working did not differ materially from those of the previous twelve months. The quantity of ore milled was 87,600 tons, and 30,244 oz. of gold was produced, realizing £121,224. In addition, £850 was received for interest, rents, etc., which made the gross income £122,074. The expenditure amounted to £114,831, and the revenue account showed a net profit to £7,243. The grade of the ore treated was 11·03 grammes, as against 11·38 grammes in the preceding year. The percentage of extraction was slightly improved, there having been no difficulty in treating the slime. Since the installation of the sand treatment plant in 1907 and the slime treatment plant in 1909, at a cost of approximately £10,000, gold to the value of £100,000 had been produced, of which £73,000 was working profit. The actual yield per ton amounted to 27s. 8½d. and the costs in Brazil to 25s. 7d. per ton. The capital expenditure consisted mainly of the Carmo River power scheme and the hoisting engine for No. 3 shaft. Both plants were now working and giving the fullest satisfaction. The additional power, conveyed in the form of compressed air, had enabled Mr. Bensusan, the mine superintendent, to install more stoping drills which were found to be both economical and efficient in working. The past year's work again established a record in development, 5,411 ft. having been accomplished. The driving of levels at the 1,040 metre horizon had been continued during the past year for aggregate lengths of 902 ft. Generally speaking, the developments had so far been disappointing at that depth. That had adversely affected the ore reserves, which now stood at 72,316 tons, showing a decrease of 2,389 tons on the previous years' estimate. Nevertheless, the superintendent remarked that he was perfectly satisfied that there was available at the present time not less than two years' supply of ore for the mills. Above the levels 770, 505, and 315, to the north-east of No. 3 shaft, very large quantities of payable mineral undoubtedly existed.

Mr. E. de Wael seconded the motion, and it was carried unanimously.

GREAT BOULDER PROPRIETARY GOLD MINES, LTD.

Directors: Sir George P. Doolette *(Chairman)*, A. Joshua, Gamble North, John Waddington. *Mine Manager:* Richard Hamilton. *Secretary:* John Gregory. *Office:* 80 Bishopsgate, London, E.C.2. *Formed* 1894. *Capital:* £175,000, in shares of 2s. each.
Business: Works the Great Boulder Proprietary gold mine at Kalgoorlie, West Australia.

THE 23rd annual general meeting was held on June 26 at Cannon Street Hotel, London, E.C., Sir George P. Doolette, J.P. (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said the shareholders would agree with him that, in view of the difficulties arising from war conditions, the company had done exceedingly well during the past year. The tonnage treated was 175,787 tons, against 195,524 tons in 1915, being a shortage of 19,737 tons, due entirely to causes beyond their control. The gross revenue for the year was £523,582, against £584,554 for the previous year. The net revenue was £262,972, which just covered the distribution to the shareholders by way of dividend, but to provide for the Australian taxes, which were somewhat serious, they had been obliged to trench on the reserve fund account to the extent of £10,000. He regarded this, however, as only a temporary loan until the war was over and their normal output was re-established. The work at the mine during the year had been hampered by labour conditions, which had been of a somewhat serious nature and had resulted in the shortage of tonnage treated. The manager in his report stated that 41 days were lost during the year, 21 of which were on account of strikes. The shortage of labour was to a large extent owing to the enlistment which had taken place of the young and capable men who had gone to the front, while the new men who had come forward to take their places had not shown the same ability or interest in their work. The development work had not been on the scale of former years, but in spite of this, although the output for the year was 175,787 tons, the reserves had only decreased to the extent of 54,887 tons. Last year they stood at 494,564 tons, while at the end of 1916 they were 439,677 tons, which meant that 120,900 tons had been yielded during the year by development, so that if they continued to develop ore in the same ratio they would have in the ore reserves another eight years' work in the mine on something like their present lines. Some five years ago he prophesied that they had five years' work ahead of them on the lines then obtaining. He was told then that he was too optimistic, but the five years had gone and his prophecy had been fulfilled, and he was bold enough again to say that they had another five years in the mine on their present lines, and he believed very much longer. There was one element of satisfaction, too, in the increased value of the ore reserves. Last year they were valued at 14·36 dwt., and this year they averaged 14·68 dwt. The shareholders might regard those ore reserves as being taken on a conservative basis, and he was satisfied that when they got back to normal conditions of labour and other requirements they would be more than pleased with the mine's production.

For years past they had been on the lookout for other properties in Western Australia and elsewhere, but up to the present time, although they had examined scores of properties and spent not a few pounds in doing so, they had not come upon a property of sufficient value to justify their taking it in hand. He could not get away from the conviction that in Western Australia there were rich fields yet to be won, and this was evidently the feeling of the Government and others interested in Western Australia.

Mr. John Waddington seconded the motion, which was carried unanimously.

WAIHI GRAND JUNCTION GOLD CO., LTD.

Directors: H. D. Bishopp *(Chairman)*, Major G. H. Earle, Stanlake Lee, H. J. Rothwell. *Secretary:* S. Leah. *Office:* 10 Throgmorton Avenue, London, E.C.2. *Formed* 1897. *Capital* issued: £384,375.
Business: Works a gold mine in North Island, New Zealand.

THE ordinary general meeting was held on June 26 at Salisbury House, London, E.C., Mr. H. D. Bishopp (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said that, although the tonnage treated was practically the same as that for 1915, the bullion, less gold duty charges, realized £215,421, against £193,771 for the previous year. On the debit side, mining and milling amounted to £97,726, against £92,614, due principally to the increased price of stores. The net profit was £49,796, and added to the amount brought forward, £8,656, gave a total of £58,493. Out of that the shareholders had received an interim dividend of 1s. per share, equal to £19,218, and the directors now recommended the payment of a final dividend of a like amount, leaving £20,015 to be carried forward. As regarded the mine and the mining outlook, developments to the end of the year were dealt with in the report, and were given in full detail in the mine manager's annual statement. Since then the main shaft had been sunk to 1,357 ft., and for the present further sinking was stopped. In the south-east cross-cut the hanging-wall branch of the Empire lode, which was cut at 116 ft. (where it was 7 ft. wide, of an assay-value of 19s. 8d. per ton), had been driven on both east and west. On the east the total distance driven was 214 ft., where the assay-value was 18s. per ton for the width of the drive, 4¾ ft., with no wall seen. A cross-cut at 210 ft. disclosed a value of 48s. 9d. for a width of 3½ ft. At 140 ft. a cross-cut to the south was put in, which holed through to the 147 ft. reef at 115 ft.; at 93 ft. from the north-west branch reef another reef was cut 84 in. wide, valued at 19s. 9d. Where the drive crossed the 147 ft. reef that reef was 14 ft. wide, and of a value of £2. 4s. 3d. per ton. The drive was continued to 145 ft. and at 133 ft. cut another branch lode 2 ft. wide, the value being £6. 5s. The Empire main reef had been driven to the east 291 ft., on ore of pay values; breaking out from the cross-cut to 30 ft. showed the reef to be 13 ft. wide, value £2. 9s. 6d.; breaking out to 82 ft. gave a width of 14 ft., value £1. 9s. The Royal lode was cut at 560 ft., giving the following widths and values: 580 ft. to 584 ft., £1. 13s. 6d.; 584 ft. to 585½ ft., £3. 0s. 6d

Major G. H. Earle seconded the resolution, which was carried unanimously.

ESPERANZA, LIMITED.

Directors : R. J. Frecheville (*Chairman*), F. W. Baker, F. M. Crisp, W. F. Fisher, A. A. Kelsey. *Secretary :* C. L. Johnson. *Office :* London Wall Buildings, London, E.C.2. *Formed* 1903. *Capital* £455,000.

Business : Holds nearly all the stock of an American company of similar name operating a gold mine at El Oro, Mexico.

THE fourteenth annual general meeting was held on June 28 at Salisbury House, London, E.C., Mr. R. J. Frecheville (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, stated that the profit for the year amounted to £8,400, which, added to the balance brought in from 1915, made a total of £13,200, from which income tax of £9,600 had to be deducted, leaving a balance of £3,600. The accounts of the Esperanza Mining Co. showed an estimated profit of £12,500 after writing off El Sirio mine expenses and construction account, to which profit had been added a credit of £23,400, represented by the exchange adjustment account, making a net estimated surplus of £38,900 for the year. Strikes were frequently occurring during the year for comparatively short periods, which interfered with operations and caused the manager much anxiety. Those strikes were mainly brought about by the economic conditions ruling, which resulted in disputes on the question of payment of wages in paper money, the purchasing power of which had been continually decreasing. It was eventually agreed by all mining companies of El Oro, with the representative of the State Government, during the latter part of the year, to effect payment of wages in coin on an agreed basis. That rise in wages resulted in satisfying the labourers for a time. On September 16, 1916, a decree was issued by President Carranza that all mining properties would be liable to confiscation within two months of that date, unless the mines had re-started operating, or relief by exemption had been obtained from the Department of Public Works. The Esperanza mine had already started milling operations about the end of April last year, and the mill had been in continuous operation since that date up to the present time ; so that the manager, in deciding that it was advisable to re-start milling—aided by the advice of the consulting engineers—might be said to have had intelligent anticipation of events. Toward the end of June, owing to difficulties between Mexico and the United States, the foreign staff left the property in the care of the Mexican staff. The situation improving, the foreign staff returned to the mine during July, and the manager again took direct charge on July 31. Another factor which contributed to the increase in operating costs, and necessitated raising the average grade of ore treated, was the higher prices paid for all supplies used at El Oro. The bullion throughout the year was safely shipped to New York. Owing to payment of labour in Mexican gold and silver coin, it became necessary to pay a premium for coin, such premium rapidly advancing to 10%. Consequently, the Mexican Government decided to purchase bullion bars from the mining companies to supply the needed metallic currency. At present, therefore, the company was disposing of its bullion in Mexico City, the proceeds being remitted by draft on New York after meeting metallic currency requirements at the mine. On January 1, 1912, Mr. Berry estimated the ore reserves at 200,000 dry metric tons, with a profit of \$638,000. During the following five years there were eighteen months, or nearly one-third of the time, when the mill had to be closed down and production ceased, and there were several occasions when the foreign staff was obliged to leave the property. Notwithstanding those difficulties, the mill treated 456,000 tons of mine ores and 244,000 tons of tailing, or a total of 701,000 tons, and won a profit of \$1,162,000. By most active development work in the upper levels, and wherever else any ore could be found, there were developed during those five years 368,000 dry metric tons of ore, which was a record that reflected credit on the general manager, Mr. Charles Hoyle, and his staff. The ore reserves at January 1, 1917, were estimated at 112,000 dry metric tons. The constantly varying cost conditions rendered it impossible accurately to forecast what profit might be won from those ore reserves, but with assumed costes, of \$9 and \$4 per ton respectively for the higher and lower grade ore, a profit of \$650,000 was to be expected. During the first four months of 1917 there had been milled approximately 80,000 metric tons of ore with an operating profit of \$163,000. The directors were unable to predict the ultimate effect the new Mexican Constitution, which became effective on May 1, 1917, might have upon mining operations at Esperanza. It would, no doubt, depend very largely upon how the various laws were administered—as, for example, what minimum wage and what percentage of the profits the Mexican Special Commission and the Mexican Central Board of Conciliation might fix as to be given to the workmen employed at the mine. A harsh interpretation of the salient points of the Constitution might easily result in the closing down of the Esperanza mine; but in that connection he was glad to say that they had received a report, dated May 28, from the manager of Esperanza Mining Co., in which he stated that the Mexican Government, through its agents, had by means of conferences brought capital and labour to a more intimate understanding at El Oro, with the hope of arranging economic conditions. The manager feared that new demands for increased wages might be made during April and May. In a special report from the manager to the Esperanza Mining Co., dated May 28, it was seen that advances in wages resulted in such an increase in operating costs that most of the lower-grade ores in the upper levels became no longer payable. He was therefore obliged to cease mining and milling most of those ores, which it had been possible previously to treat profitably. The reduction in the available stope areas had compelled a reduction in tonnage treated to about 10,000 tons monthly, and the reduction in tonnage treated caused a further rise in cost per ton, so that on May 28 the minimum payable grade of ore stood at \$8,70 per ton. As nearly as Mr. Hoyle could estimate at the present time there remained 65,000 tons of such ores now payable, and he estimated the profit in those ores at \$175,000, besides which there was some still payable old-filling which should further increase the profit. The directors had decided to recommend the payment of an interim dividend of 1s. per share on July 31 to all shareholders registered on the books of the company on June 30.

Mr. F. W. Baker seconded the motion, and it was unanimously adopted.

THE ZINC CORPORATION, LIMITED.

Directors: F. A. Govett (*Chairman and Managing Director*), T. J. Hoover (*Managing Director*), J. A. Agnew, H. W. Pelham Clinton, R. W. Skipwith, P. Lyttelton Gell, W. C. C. Romaine, Tyndale White. *Local Board in Melbourne:* T. B. Birkbeck, W. M. Hyndman. *General Managers:* Bewick, Moreing & Co. ***Superintendent:*** C. G. Hylton. ***Secretary pro. tem.:*** T. E. Smith. ***Office:*** 20 Copthall Avenue, London, E.C.2. *Formed* 1907, expanded 1911. *Capital* issued: £245,692 in preference shares of £1 each and £326,569. 10s. in ordinary shares of 10s. each.

Business: Operates the South Blocks lead-zinc-silver mine at Broken Hill, New South Wales; treats old dumps of zinc tailing by flotation for the production of zinc concentrate.

THE sixth ordinary general meeting was held on June 25 at Salisbury House, London, E.C., Mr. F. A. Govett (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said they would recall that in the circular issued last September they were informed that writs had been issued against the parties concerned in the attack which was made against the board. The board had now received from Mr. Auld and Mr. Leonard a complete withdrawal and apology; the actions had, therefore, been discontinued.

The developments in the mine were all satisfactory. The ore reserve had been increased to 1,700,000 tons, and the probabilities of the future were still good. Their policy still would be, as soon as labour was available, to press forward with the development of the south end of the mine, driving south to link up with the zinc lode workings and also to connect with the South Extended mine. This programme was postponed when profits were rendered doubtful by the war and labour was insufficient. They now had money, and only labour was required for more rapid progress. Labour was very scarce, for many of the best men were fighting. Of the staff and labour roll 117 men enlisted, of whom nine had lost their lives. The labour that remained had been difficult and clamorous. Operation had been much hampered, although they had been working full scale most of the time with both concentrators, lead and zinc. In the latter case there had been no outlet for more than the proportion of the amount which the Zinc Producers' Association had been able to sell, and the rest of the zinc concentrates were being stacked. The reason for this restriction of deliveries was, of course, the lack of shipping.

With regard to the position of the metals, that of lead was comparatively simple, for in the Associated Smelters they had the outlet for the lead concentrates. He could testify to the admirable way in which this company was operated both in Australia and also here in London by the managing director, Mr. W. S. Robinson. He had pleasure in again making this reference to what Mr. Robinson had accomplished, for not only in the administration of this company, but in all his prolonged skilful and tactful conduct of the business of this company and of the Zinc Producers' Association, his work had been beyond all praise. In Mr. Robinson they had a notable case of development and rapid growth of wonderful ability. The products of the Associated Smelters were of the highest class, well known throughout the world. The conversion of the concentrates into lead and subsidiary products could not be better handled, and the company had the largest and best smelter in the world. During the last half of last year there was a vast improvement in the results at the Associated Smelters. The tonnage of concentrates treated was increased by nearly 50%, while the cost of smelting to the companies was reduced by nearly 20s. a ton; this in spite of an increased cost for coal of 4s. 5d. per ton, which, indeed, was likely to increase still further. This result was due to increased efficiency in the shape of higher recoveries, and in this direction the probabilities were not exhausted. Further improvements were also being made in the way of gas firing in the refinery, which should mean great saving, and a large new power plant was being installed, from which a saving of 6s. or more per ton of concentrates was expected. The capacity was now nearly 150,000 tons of lead per year.

The inability of the corporation to dispose of its zinc concentrate raised the whole question so much discussed of zinc smelting in the Empire. Before the war this was mainly an American, German, and Belgian industry, and there was a Continental ring controlled by Germans which controlled the industry. As explained a hundred times, the corporation's concentrates were sold to Germany because there was no other outlet. The result of this was that the larger part of the profit on this British material was made by Germany. On the outbreak of the war the business was clean cut off, and, worst of all, there was so little British spelter that the Empire had had to pay millions and millions in extravagant prices for spelter to America, where plants had since enormously increased to meet demand. Broken Hill concentrates found an outlet there, until at present there was no freight to take the concentrates to America. He would like to repeat what he said last year, that not only this industry, but the whole Empire owed a debt of gratitude to Mr. Hughes for the energy which he imparted to the pre-existing inertia of this country by his vigorous and far-sighted statesmanship. That they were now awakened was largely due to the influence of his precept and example. The Associated Smelters had a small plant, which produced about 5,000 tons, mainly for the Australian market, and the Electrolytic Company would be coming gradually, but surely, into operation. This shortage of a vital munition of war soon gave rise to a clamorous demand for British spelter works. But these, he thought, could not be extended to take the whole of the raw material of the Empire. They must be limited in capacity to provide for the normal British demand. This, of course, was most desirable, but in his judgment only to this extent and no further.

For the production and disposal of concentrates, lead and zinc, the Broken Hill mines had formed three companies: the Associated Smelters for lead, the Zinc Producers' Association, and the Electrolytic Zinc. A small company had also been formed for roasting concentrates at Broken Hill in order to produce sulphuric acid on the field. In all these the corporation had taken its share. But they must always do some experimental work, and they thought it right to take their interest in the Sulphur Syndicate, which owing to the war still remained unproved, and some time ago they took a one-third interest with the Burma Corporation and the Swansea Vale Smelters in the Chloride Syndicate, which was formed to prove a process to deal with zinc-lead ores, in which by the introduction of a double salt the lead was thrown down, and replaced by zinc from zinc chloride, leaving two products, first, the lead itself, and secondly, a zinc residue, with but a very small amount of lead, which would be an ideal material to smelt. There were one or two difficulties to surmount, but it looked like working out all right, and if so it would seem to point in the direction of the elimination of lead smelting and the production of a zinc material easy to treat by either process—distillation or electrolytic. They would take their part, when the opportunity came, in the English company under the Government assistance, which was destined to make up the complement of the production of sufficient spelter to fill the Empire's demand. This would require financing, and he had to show them how they could finance all this and still pay dividends. First of all, the money at their disposal for this purpose was the capital replaced as they used up the tailings which were purchased. This tailings redemption fund was capital, and never was available for dividends, and, as they had left some 1,150,000 tons of tailings, they would put by sooner or later about another quarter of a million sterling. This sum was more than sufficient for all the demands that were likely to be made, but it would only gradually become available. In the meantime, they were making large profits, and though they were distributing all they made, the profits were not immediately distributed. There was an interval of some months, so that they always had a considerable sum in cash at their disposal, which provided the temporary finance and enabled them to provide, without recourse to bankers' loans, their participation in these various subsidiary enterprises, until they finally provided the money from this tailings redemption fund. There was one exception to this, the first £100,000 for the Associated Smelters was provided out of profits, for at that time they had not got the cash. The directors were determined to take their full and proper part in broad-minded co-operation at Broken Hill. For this reason, as well as for the advantages that would accrue, they had subscribed one-fifth interest in the Tasmanian Electrolytic Zinc. The commitment in the Electrolytic Company at present was limited to £100,000 and that would be only required in slow instalments. The last remaining enterprise in which they must have their part was the erection of the proposed works in England. In this case their part of the capital required would not be large and it would not be wanted for a considerable time.

With regard to dividend payments, the present method was open to the objection that they began paying the preference dividend only three months after the beginning of the year, possibly before it was even earned. This never was the case; but it was possible. The routine he now proposed was: In June to pay the first preference interim for 1917; in September the final ordinary for 1916, in December the final preference for 1917, and in March the first interim ordinary for 1917, and so on. The difficulty was that they could not pay on the ordinary until they had paid the preference in full, and he did not like taking risks of starting the preference too early in the year. The effect of this was that they had postponed the preference three months and advanced the ordinary three months, which he presumed was what the majority would desire. The net profits for the year were £212,000 which enabled them to pay a dividend equal to the highest ever paid, and this after writing off depreciation and one small bad debt, or doubtful debt. For this debt when made, there was ample security, which so far had failed to make good owing to the drastic nature of the reorganization of the General Petroleum. This they might still get, but this seemed a good opportunity for doing this. They would have liked to do the same with the Hirsch debt, but this they could not do, for in effect it was written off two years ago. It was never taken into the accounts, but carried to a suspense account, for even from the first they thought it prudent to treat this as very doubtful. Still they would receive on this account on this side some £10,000 from realization of assets in England—namely, shares in the Swansea Vale Smelters—and some amount in Australia. He questioned very much how far they could enforce payment of the balance in the German Courts after the war. In further explanation of this matter he would say that while the shares which were sold by the Public Trustee were open to certain objections, in their opinion they were worth a great more than the price at which they were sold. They thought it would be a much better position to have these shares than an action for money in a German Court, and therefore they actually made a much higher bid "in terms of the enemy debt"—that is to say, they offered to exchange £70,000 of this debt for the £100,000 in shares, and in order to meet the objection that this would not be fair to the other creditors they offered to allow each creditor to take his proportion on the same terms. This proposal, however, the Public Trustee would not accept. The result was that their debt was only reduced by this small amount and they had not got the shares. On the various holdings in the schedule the valuation given last autumn still held good, and in no case would there be any question of writing off, even if there were some depreciation, for the value of the total property account so largely exceeded the amount at which they stood in the balance sheet that the question could not well arise. As regards the items in the accounts there was not much change in detail since last September, the chief difference being that the interest in the Inter-Californian Trust and the General Petroleum notes had now become preference stock in the General Petroleum. This company was now in fine shape, and this might be regarded as a first-class American industrial, selling about par in New York. The common stock was over par and paying 10%. The only other holding which needed explanation was the unfortunate Granville interest. In some ways the position was worse, but in reality it was better, for in the face of the financial exhaustion of most of the original people, who had been struggling with this big business for years before the corporation came in, it became impossible to provide in times like these the large amount of funds that were required to see it through. Therefore, in view of the danger of the floating liabilities, they took steps to have a receiver appointed. This had been accomplished, and it would now be possible not only to provide the money, which indeed had been done, to protect the properties, but also to work out some comprehensive scheme for the finance or amalgamation of the companies and place them under proper management, which up till now had been literally impossible.

Mr. Tyndale White seconded the resolution and it was carried unanimously.

The Mining Magazine

FOUNDED IN 1909 BY T. A. RICKARD AND EDGAR RICKARD.

W. F. WHITE, *Managing Director*. EDWARD WALKER, M.SC., F.G.S., *Editor*.

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD.,
AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938*. Telegraphic Address: *Oligoclase*. Codes: *McNeill*, both Editions.

BRANCH OFFICES { 420, Market Street, San Francisco. 2,124, Equitable Building, New York.

SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XVII. LONDON, AUGUST, 1917. No. 2.

CONTENTS.

EDITORIAL

THE MINISTER of Munitions has assumed control of the iron mines of Cumberland and the Furness district of Lancashire. The iron ore of these mines is hematite of the highest quality, occurring as a replacement in limestone, and it was the ore on which Bessemer developed his process. We believe that at many of the mines there are surface dumps of low-grade ore that will under present conditions repay concentration.

SUBMARINE activity accounts for the loss of many Australian publications, and our Mining Digest this month is the poorer in consequence. While on this subject, it is appropriate to refer to the partial failure of the duplicate posting of letters. Australians have sent their correspondence by alternate routes, via Vancouver and via San Francisco, and find that the two consignments join the same boat out of New York. The duplicates, therefore, brave the worst part of the voyage in company.

ZINC and lead ore producers in this country, having formed themselves into an Association, are now reorganizing their methods of sale of zinc concentrate. According to the new arrangement, all the producers selling to each individual smelter are to combine in their dealings with such smelter. The aim is to secure a contract for the whole output of each group for the period of the war and for six months after. They hope in this way to secure better prices than heretofore. Maybe they will, but we doubt it.

MR. "FAIRIE," the winner of the New Derby with Gay Crusader, is in private life Mr. A. W. Cox. He was one of the fourteen original shareholders at Broken Hill. At the time he took the mining interest he was a squatter in the Darling River district, where he was associated with one of the sons of Charles Dickens. Mr. "Fairie" has been for thirty years a faithful supporter of racing and horse-breeding, and many of his horses have achieved fame, notably Lemberg, who won the Derby in 1909, and Bayardo, a great sire.

THE "Technical Committee" has strong advocates and equally strong opponents. Theoretically there is wisdom in the multitude of counsellors, but in a community, however small, where all rank equally, the distribution of duties and the fixing of responsibilities are difficult of attainment. The controllers of the Burma Corporation found that the arrangement was not suitable for their requirements, and they decided to revert to the more customary plan of retaining a consulting engineer who devotes the whole of his time to their business. Accordingly they appointed Mr. A. F. Kuehn to this position, and the step has been justified by results. Among the directors of the corporation are three engineers, Messrs. R. Gilman Brown, J. A. Agnew, and Walter McDermott. These, with the consulting engineer, may be considered to constitute an unofficial technical committee, Mr. Kuehn taking the initiative and executive duties, and the others acting as advisers, a truly ideal arrangement.

FULL information is now to hand relating to the four areas in the Far East Rand offered on lease by the Government of the Union of South Africa in June. Our Johannesburg correspondent gives particulars on another page, and the map accompanying his letter shows the positions. The general opinion is that the Consolidated Mines Selection and the Goerz group will be the successful bidders, the former taking the two properties touching both Brakpan and Springs, and the area east of Geduld going to the latter.

IT IS allowable to poke fun at the censors now and again. When General Pershing landed in England, the news was given to the American press with studied circumspection. It was announced that he had landed at a British port, the name of which could not be divulged, yet in the account it was stated that the Lord Mayor of Liverpool was among those present at the landing stage to meet him. Similarly, when the American commission of engineers went to Russia, it was stated that they landed at a Russian port on the Pacific. At present, Vladivostok is the only likely port for such entry.

QUALIFICATION for membership of the American Institute of Mining Engineers is to be considered once again. A circular has been issued inviting the expression of opinion on this subject, and there is little doubt that the discussion will take tangible form this time. The attempt of ten years or so ago to place the Institute on a sound professional footing failed for reasons now sufficiently well known, and it led to the establishment of a rival organization, the Mining and Metallurgical Society of America. Recent attempts to amalgamate the new Society and the old Institute have proved unsuccessful. But the existence of the Society is of course an absurd anomaly, and nobody recognizes this more than the average member. The present proposals of the Institute provide for a gradual tightening of the entrance requirements, and do not involve present members. This slow method of reform is much preferable to the old ideas of "reconstitution in hustle," and will surely provide the best policy for re-adjusting the professional position of the American mining engineer.

THE Committee for Scientific and Industrial Research has constituted two new sub-committees during the past month. The first of these has been appointed to inquire into the various types of breathing apparatus used in coal mines, and to demonstrate by experiment their advantages, limitations, and defects; also to suggest improvements, and to advise on the desirability of standardizing. Dr. J. S. Haldane, our leading medical authority on mine air, is naturally a member of the committee. The secretary, Mr. Alexander Richardson, is a well known Rand engineer, and a few years ago occupied the presidential chair of the Chemical, Metallurgical, & Mining Society of South Africa. The second committee, which is really a subsidiary of the Fuel Research Board, has charge of the Irish peat question, and Professor Pierce Purcell, of University College, Dublin, is the secretary. We have only recently uttered a warning against the uncontrolled destruction of organic life on the surface of the earth in connection with proposals for the unrestricted development of peat deposits. The drainage of bogs and the conversion of peat into fertilized soil is a more beneficent project than the drying and burning of the peat. And as regards power for Ireland, the water resources deserve first attention. The denudation of the earth by wanton destruction of trees and raw materials for soils has been the cause of many national calamities by the reduction of a smiling landscape to a desert. Hence our hint to the Irish peat committee.

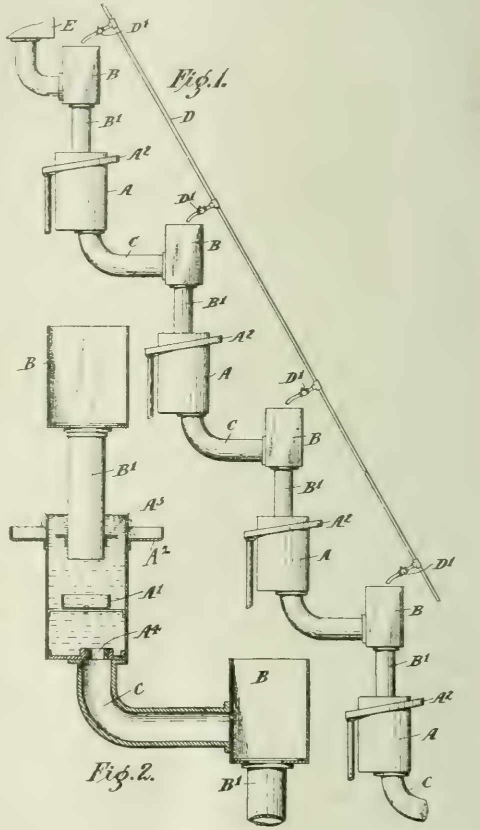
Soluble Frothing Agents.

Owing to a regrettable misprint our paragraph in the July issue, relating to the result of the appeal by the Miami Copper Co. against the judgment in favour of Minerals Separation, read like nonsense. When we wrote "revised" the printer put "reversed," and we did not detect the error when reading the proof. The word "revised" seemed apt for the occasion, for though Minerals Separation won the appeal, it was not by the unanimous judgment of the court, and the majority judgment against the Callow plant was not as strong as that of the court of first instance. Therefore our remark that the Supreme Court may again be asked to adjudicate.

The arrival of the complete text of the judgment shows that the appeal was not limited to a consideration of the Callow plant, for two patents covering the use of soluble frothing agents were also included in the argument. The first of these, 962,678, issued to Sulman, Greenway, and Higgins, and corresponding to British Patent No. 2,359 of 1909, claims the application of soluble organic frothing agents; and the second, 1,099,699, issued to H. H. Greenway, and corresponding to British Patent 18,924 of 1910, covers the use in connection with copper ores of aromatic hydroxy compounds such as phenol and cresol, used in a cold solution without acid. The first patent is held by the first court and by the appeal court to cover the use of the organic compounds miscible in water obtained by the distillation of coal or wood. The use of pine oil and coal-tar compounds, substances on which much reliance is placed in America, therefore comes under the control of Minerals Separation. As regards the second patent, the court of first instance held that there was no novelty, but the court of appeal held a different view, as the advantages of working in a cold instead of hot solution and without sulphuric acid were obvious. The three judges were agreed as to the validity of the two patents dealing with the soluble frothing agents; it was only in connection with the infringement by the Callow process of Minerals Separation patent 835,120, known as the "less-than-1%-oil" patent, that there was a division of opinion. Engineers have always recognized that the adoption of the light oils was a most important step in the evolution of the commercial flotation process. Other methods employing heavy oil or no oil at all required complicated and expensive plants and were not efficient as regards recovery and working costs. The advent of the lights oils and miscible frothing agents made it possible to use much simpler machinery. The Minerals Separation and the Callow plants are far cheaper than those used by De Bavay or Elmore. More recent plants, such as that at Inspiration, or that invented by Messrs. Seale and Shellshear are still simpler, and the uninitiated spectator often wonders why such easy-looking processes were not adopted long ago. The answer is that these simple plants were only made possible when the principle of small amounts of soluble frothing agents was established.

Flotation by Cascade.

Two years or more ago experimental work was begun by Messrs. H. V. Seale and Wilton Shellshear at the Junction North mine, Broken Hill, with the object of developing a method for introducing air bubbles and creating froth for flotation purposes, whereby the amount of power required is very considerably reduced. Agitation by impeller used in the Minerals Separation plant, and by compressed air in the cell and Pachucca tank employed by Callow, both consume much power. The principle adopted by Messrs. Seale and Shellshear is that of the cascade; that is to say, the stream of pulp is caused to fall into water, the incoming stream entrapping air, which is subsequently released, and on rising acts as the buoying agent. This method of catching and compressing air by falling water is sufficiently well known, for it has been applied for the purpose of supplying compressed air to mines, a characteristic case being that introduced several years ago at Cobalt, Ontario. The cascade system has been applied recently for flotation purposes in America. We made reference in our June issue to the Crowfoot method and in our July issue to Wilfley's plant. The Seale and Shellshear process has been kept quiet by the inventors and by the Junction North, and also by Minerals Separation, the Sulphide Corporation, and the Zinc Corporation, which have severally improved the process. Seeing that American inventors have advertised their discovery of methods founded on this principle, it is permissible for us to give some information relating to the Seale and Shellshear process, the more so as we understand that Minerals Separation, the controllers of the patents, has sent a representative to America to explain the process and experiment on its application to copper ores. We have no information relating to the construction of the plant actually employed, but it is sufficient to quote the specification of British Patent 10,666 of 1915, granted to Messrs. Seale and Shellshear. According to this patent the pulp is fed to a mixing box B, open at the top, from which it passes downward to a separating box A, also open at the top, through a pipe B^1, which delivers the pulp below the surface of the water in A. The baffle A^1 is placed in the box A so that the downward current of pulp and air shall be broken. The liberated air carries some of the sulphides upward, and after passing the baffle A^3 they are discharged into the annular launder A^2. The unaffected pulp passes through the orifice A^4 and the pipe C to the next mixing box B. The flow of the pulp through the pipe C causes a vigorous agitation. Additional water is introduced at the head of



DIAGRAMMATIC REPRESENTATIONS OF THE SEALE-SHELLSHEAR CASCADE FLOTATION PROCESS.

each successive mixing tank to compensate for that removed with the concentrate. Patent specifications are not usually convincing until the value of the process is substantiated in practice. For this reason it is desirable to say that in this case the process has proved extremely successful at the Junction North, Central, and South Blocks mines. The details of construction of the actual plants are of course only suggested, so to speak, by the drawings in the patent specification. In practice the process is applied to the preferential separation of galena and blende. At the Central mine, half of the agitation plant has been laid by, in favour of the new process. According to the new method at the Central, the mine ore is first jigged for the removal of as much galena as possible, and the tailing, after regrinding, is sent direct, without any tabling, to the Seale-Shellshear plant. The oiling medium is added before the pulp goes to the flotation apparatus. The lead is removed in the first few separation boxes. Subsequently acid is added, and the blende is thereby floated. We cannot give more details now, and we await with interest some official pronouncement by Minerals Separation of the results obtained by this new process at Broken Hill and elsewhere.

Studies of Laterite.

On another page we commence the publication of an article by Mr. J. Morrow Campbell containing a close study of the constitution and origin of laterite. This article may possibly be of greater interest to the scientist and geologist than to the average mining engineer, and it may even appear dry to the layman. The general unpopularity of the subject is largely due to the uncertainty as to the exact meaning of the word "laterite." In the strict sense of the term, laterite is an earth or soft amorphous rock consisting of varying mixtures of hydroxides of aluminium and iron, usually accompanied by free silica and oxide of titanium. By convenience its use is confined to the occurrences in which iron preponderates over the aluminium; when the aluminium content is high, the word bauxite is used, and bauxite is the chief commercial ore of aluminium. The confusion of definition to which we have referred arises from the fact that the term has been wrongly applied to ferruginous clays, such as lithomarge, and even to sedimentary iron ores in general. It is necessary therefore to say that in true laterite the aluminium hydroxide is not combined with silica as silicate of alumina, otherwise clay, but that any silica present exists as an independent mineral. It often happens, however, that undecomposed clay is present. Laterite is found abundantly in hot, damp, and flat countries, and it is the residual product of the degradation of igneous rocks, generally being produced *in situ*, though in some cases it is of detrital origin. As regards the mode of its formation and the agents that have decomposed the minerals of the igneous rocks, a great deal has been written by English and French geologists. Among the former may be mentioned Holland, Oldham, Maclaren, Fermor, Mennell, and Holmes, and among the latter Lacroix and Laur. Moreover, Mr. Morrow Campbell has on a previous occasion written on the subject. The question of the formation of laterite is closely allied to that of the formation of kaolin and other clays. The theories assume the decomposition of the complex silicates of aluminium and other metals. Felspars lose their alkali and lime and become hydrous silicates of alumina. The ferro-magnesian silicates, such as biotite mica, lose their iron and magnesium with the same result. The quality of the clays thus produced depends on the extent to which the chemically separated material is mechanically removed, and on the presence or absence of other accompanying impurities. For the formation of laterite or bauxite it is necessary to assume that the silicate of alumina has been split into its component oxides by a further agency of degradation. Some authorities consider that the iron in laterite is the iron in the ferriferous minerals, which has remained *in situ*. Mr. Morrow Campbell, on the other hand, holds that the iron in the minerals was entirely leached after their split-up, and that the iron in laterite has been deposited in the porous hydroxide of alumina after the decomposition of the clay and the removal of the silica. The agencies that have brought about all these alterations have been discussed in detail by the authorities quoted, and by others. We cannot afford space to go into all these theories. For the beginner, we can recommend the chapter on laterites in Mr. F. W. Clarke's "Data of Geo-Chemistry," and the section devoted to kaolinization in Mr. J. Allen Howe's "Kaolin." We hope that these prefatory remarks will encourage some of our more modest readers to tackle Mr. Morrow Campbell's article and enable them to follow his arguments as to the nature and origin of laterite.

One feature of Mr. Morrow Campbell's method of study to which attention should be drawn is his plea, and his example, for the use of the microscope in the investigation of mineralogical problems. He is one of the cleverest microscopists we have in the mining profession, apart from the professors of geology and mineralogy. Evidence of the excellence of his work was given at the meeting of the Institution of Mining and Metallurgy two years ago when he read his paper on the mode of occurrence of gold in Ashanti. In the present article he shows that chemical analyses are not sufficient, often being indeed entirely misleading, and that a careful mineralogical analysis is also necessary. A chemical analysis reports the percentage of silica and alumina, but gives no indication whatever of the physical and chemical relations of these two items of the analysis. In fact it is impossible to say whether the two exist independently or whether they are combined in part in the form of clay. Moreover the water constituent of the sample is not allocated to its chemical combinations, so that the extent of hydration of the various oxides cannot be determined. Mr. Morrow Campbell does a distinct service in laying this stress on the necessity for mineralogical analysis, and his advice may be taken with advantage by every engineer who reports on an ore deposit. It is not sufficient to know the assay-value of a gold ore and the degree of fineness of the distribution of the metal. Not long ago an elaborate plant was erected to treat a gold-ore by all-sliming and cyanidation, this system being adopted because the extraction by amalgamation was low. The method was adopted in face of the advice of an engineer who saw that the gold was in hard sulpharsenides and not in the soft gangue. There was no need to put the ore as it came from the mine through tube-mills; coarse crushing and concentration would have answered much better. The failure of the directors to appreciate the value of microscopic analysis led to low recovery, high costs, and trivial profits. Mr. Morrow Campbell's article will thus serve two purposes: first to elucidate the theory of the formation of laterite, and second, but to investors much more important, to impress on directors and engineers the advantages of complete mineralogical analysis.

Perran and St. Piran.

He is an unromantic individual who can visit the Perran iron lode in Cornwall without giving a thought to old St. Piran, the miners' saint. He was a kindly man and easy going, not at all resembling his grim brethren whose chief object was to make life a burden. His sphere of activity, or inactivity, was the country between St. Agnes and Penhale Point, and his memory is preserved in the names Perran Beach, Perranporth, and Perranzabuloe, as well as in the Great Perran lode. The legend has it that he taught the Cornishmen to "stream" and mine for tin and other metals and to smelt the ore; without, however, engaging in the business himself, preferring to lead the life of indolence as a collector of patent royalties or of lord's dues. It is usually said that tin was his objective and the source of his revenue, but after the study of the history of mining in the neighbourhood the inclination is strong to attribute his wealth to silver. To explain this view we may give a brief account of the Great Perran iron lode. This lode has received the attention of many eminent geologists, Borlase, Henwood, Warington Smyth, De La Beche, and Collins, and various parts at various times have been worked for silver-lead, zinc, copper, and iron. The references most easily accessible at present are contained in the late Mr. J. H. Collins' "Observations on the West of England Mining Region," and in Mr. C. Parkin's paper read in 1878 before the North of England Institute of Mining and Mechanical Engineers. The lode extends inland from the cliffs at the northern end of Perran Bay for a distance of several miles in a south-east and easterly direction. The width varies considerably, but the average may be taken at 15 to 20 ft. The mean dip is 45°, and there are numerous upthrow faults. The outcrop consists of a silicious mixture of brown hematite and earthy carbonate of iron, and this has in former years been worked as an iron ore. Below the weathered zone the lode material is largely siderite, the spathic carbonate of iron. The quartz constituent is often high, and manganese minerals are found in fairly large quantity. In the hanging-wall side of the lode blende is in many places abundant, and has been extracted successfully at one or two of the mines, such as the Great Retallack. Copper sulphides and galena are also found occasionally. Branch and cross veins carry lead and copper minerals, and the galena is usually argentiferous. A narrow branch vein at the Duchy Peru mine has yielded galena assaying as much as 2,000 oz. silver per ton, and the Treamble workings have similarly yielded much lead and silver from cross veins. Over half-a-dozen mines have been opened and iron ore extracted on a commercial scale. From the personal point of view, the most interesting of these is the Mount mine, on which a great deal of exploration and development was done by the late Mr. John Hollway, a practical metallurgist whose pioneer work in various directions has not received the public credit it deserves, his services in the application of bessemerizing in copper metallurgy, for instance, being only grudgingly acknowledged. As regards the amount of iron ore extracted from the Great Perran lode, the late Mr. J. H. Collins estimated the total at over 200,000 tons. No ore has been raised for the last thirty years. As we mentioned in our March issue, some of the old workings are being examined with a view to reopening, owing to the Munitions Department seeking for every possible home source of supply of iron ore. Undoubtedly the quantity of material is great and can be counted by millions of tons, but its quality is not of the best owing to the presence of quartz and many other minerals, and moreover the irregularity of its composition as regards iron content is a great drawback.

As regards the classification and theory of origin of the lode, there can be little doubt that it belongs to the Devonian group of lodes formed by upward infiltration. The same type of lode is worked for iron in Westphalia and Hungary. In many cases lodes of similar age and constitution are proportionately richer in the sulphides. For instance, at the Bunker Hill and Sullivan lead-silver mines in Idaho, the preponderating gangue mineral is siderite, accompanied by quartz and manganese compounds. The late Mr. Collins regarded the iron oxide capping as a gossan, and he was of opinion that copper and then tin would be found in depth. This theory does not attract us, any more than the theory sometimes expressed that the lode is a contact-metamorphic deposit of Pre-Cambrian age. To return once more to the miners' saint, the geological description which we give of the lode offers some substantiation for the supposition that in the early days lead-silver was the chief provider of riches for the county.

St. Piran was, geologically, not only associated with ore deposits but was also the victim of denudation and subsequent rock-formation. The Perran sand-dunes afford an apt illustration of the æolian agency, and consist of what the Geological Survey calls in old-fashioned terminology "blown sand." He lost two of his churches in succession, one being entirely engulfed and the other wrecked. If our readers want a good holiday story, they should read the Legends of St. Piran, contained in the "Delectable Duchy," by Quiller-Couch. It seems late in the day to recommend a book of old and established reputation, but our excuse is that few mining engineers, even including Cornishmen, have ever read it. Quiller-Couch is a Cornishman and evidently knows the local miner. He tells us that St. Piran introduced the art of divine laziness into Cornwall from Ireland, and that he sat on the sands and taught the people how to be idle. On his anniversary day, the miners sent the sleepiest boy in the neighbourhood to a comfortable place with instructions to sleep there as long as he could, and by immemorial usage the length of his nap was the measure of the miners' afternoon siesta for twelve months to come. St. Piran's indolence excited the wrath of the other saints with which Cornwall swarmed in those days, and a deputation, containing both male and female representatives of the sainthood, among whom may be mentioned St. Petroc, St. Neot, St. Just, St. Columb, St. Blazey, St. Iva, St. Agnes, St. Uny, St. Erme, St. Allen, St. Day, St. Dennis, St. Enoder, St. Mawgan, St. Eval, St. Mewan, St. Gluvias, St. Austell, St. Erth, and St. Mawe, determined to pounce on him unannounced in order to investigate the real state of things in his parish. Readers who are acquainted with the map of Cornwall may add the names of many other saints. Scoffers allege that these saints only came to Cornwall after hearing of St. Piran's success in metal mining, and that their proceedings now recorded were prompted as much by mining jealousy as by religious anxiety. A fortunate vision of the assembling of these saints at Bodmin Priory gave him warning of their approach, and then for the first time in years he bethought himself that there was a church, or should be, some where in his neighbourhood. But the church could not be found, and though some of his flock with good memories remembered that there used to be one and even recollected its style and design, none could manage to indicate its whereabouts. Vainly did they all trudge the sandhills, until by lucky chance the saint placed his foot on yielding ground at the top of one of the dunes, and precipitately disappeared into a cavity below. Here at last was the church, covered with blown sand. The flock scrambled down after their patron, and the service began just as the cavalcade of visiting saints appeared over the edge of Newlyn Downs. Let us quote Quiller-Couch's own version of the explanation of the event, which he puts in St. Piran's mouth: "We thought ye were throat-cutting Danes by the way ye was coming over the hills three hours back. And the trouble we've had to cover up our blessed church out of sight of thim marautherin' thieves! And the entire parish gathered inside here and singin' holy songs in expectation of imminent death! And to think 'twas only you holy men all the while! But why didn't ye send word ye was comin', St. Petroc darlint? For its little but sand ye'll find in your mouths for breakfast, I'm thinking." This incident provides one explanation of the origin of æolian deposits. It also shows that St. Piran is the modern saint, not so much of the Cornish miner as of the mining engineer in all parts of the world, for the latter, with cheery irresponsibility, notoriously forgets the existence of his churches.

REVIEW OF MINING

Introductory.—The commencement of the third year of the great war brings no hope for any speedy end of hostilities. The Russian position becomes more serious daily, and anarchy reigns in many places, industrially as well as from the military point of view. The United States Government has prohibited the export of iron and steel except for the war requirements of the Allies. Its intention with regard to the settling of a reasonable price for copper has not yet been declared, and in consequence the market is unsettled; the fact, however, that the price has got to come down has made it possible to reduce the price of standard in this country from £130 to £125. The strikes in various copper-mining centres are causing some disquietude. Shortly after our last issue, silver rose to 41d. per ounce, and after a slight recession, advanced once more, and at the time of writing, August 11, stands at $42\frac{1}{16}$d. In the metallurgical world, our statement relating to the cascade flotation process should attract attention.

Transvaal.—Two months ago we referred to the gradual decline in the native labour supply on the Rand. The numbers fell again during May and June, and at the end of the latter month the figure was 175,727, as compared with 199,330 at the end of October. Unfortunately the position has not improved during July, the figure on July 31 being 171,653.

The results of development at the Daggafontein mine continue to improve, and the outlook is now far brighter than when the deal was made between Henderson's and the Consolidated Mines Selection. These results not only justify the belief of the companies' engineers that the early development was in a part of lower than average grade, but they augur well for the future of the eastern and southern sections of the Far East Rand basin. The Daggafontein is one of the largest properties in the Far East Rand, being exceeded in size only by the Government Areas, where curiously enough the early development was similarly by no means encouraging. During the June quarter at the Daggafontein, out of 2,800 ft. sampled, 48·3% was in payable ground, and averaged 40·67 dwt. over 11·6 inches.

An arrangement has been made between Henderson's Transvaal Estates and the Rand Selection Corporation (formerly the Transvaal Coal Trust) whereby the former takes control of the coal-mining interests of the latter, the chief asset being Oogies colliery. It will be remembered that the Rand Selection Corporation and the Consolidated Mines Selection recently acquired control of the Daggafontein gold mine that had previously been in the hands of Henderson's Transvaal Estates. Henderson's controls the Tweefontein Colliery Co., which does an excellent business in the Transvaal, and it has also developed the Tweefontein No. 1, which will be ready to start production in a month or so. Eventually the plan is to amalgamate Tweefontein, No. 1, Oogies, and other property, as the Tweefontein United Collieries. When No. 1 starts work, the total output of the new company will be about 100,000 tons per month, and the Tweefontein United thus will be the most important coal producer in the Transvaal.

A year ago we recorded that operations at the West Rand Central, a small property in the far west Rand, were being suspended, on the advice of J. W. H. Stubbs, owing to the exhaustion of the payable ore. Liquidation of the company is now nearing completion, and shareholders are likely to receive a return of 2s. 6d. per £1 share as return of capital.

The position at Bantjes is becoming serious, for the development on the Main Reef Leader, on which hopes were founded, has given consistently unsatisfactory results during June and July. The Central Mining Corporation had indicated a willingness to advance additional capital for further exploration, but in view of present results this intention has been rescinded, and the probability is that work will be entirely discontinued and the mine closed.

The Transvaal Gold Mining Estates conducts some of the most interesting operations in the Transvaal, but it is overshadowed by the Rand goldfield. The deposits at Pilgrim's Rest were known and developed before the Rand was discovered, and to the late Nicol Brown is due the credit for introducing the first South African gold-mining proposition in London. The deposits are not likely to continue profitable for many years, for in spite of vigorous development the chance of finding additional ore-bodies becomes less and less. During the year ended March 31, the total yield at the three groups of mines was worth £400,500, or 41s. 3d. per ton, and the working profit was £169,787, out of which £75,528 has been distributed as dividend, being at the rate of $12\frac{1}{2}$%. The reserve is estimated at 379,043 tons, averaging 9·9 dwt., which is rather less than a two years' supply. The ore at these mines contains copper, and special methods of cyaniding had to be devised. The practice is described in a paper appearing in this month's Mining Digest.

Rhodesia.—The output of gold during June is reported at £302,195, the highest monthly figure this year, and comparing with £333,070 for June 1916. The Cam & Motor shows a fall of £2,500, with a working cost higher than the revenue. The output of coal was 41,837 tons, of copper in ore shipped 347 tons, chrome ore 3,805 tons, and asbestos 859 tons.

The Eldorado may be considered as the second most important gold mine in Rhodesia, though it comes a long way after the Globe & Phœnix. It contains many patches of exceedingly rich ore, but their existence is only vaguely indicated in the published reports. From 1908 to 1913 dividends averaging 30% were paid, on a capital of £300,000. Afterwards the length of the shoot contracted, the assay-value fell from 1 oz. to 14 dwt., and the dividends dropped to 15%. Now comes the unwelcome news that developments on the 20th level are disappointing ; in fact, Mr. Cyril E. Parsons, who has succeeded the late H. A. Piper as consulting engineer, considers that the ore-body has come to an end. During the year ended March 31, 50,331 tons of ore yielded gold worth £122,347, and £45,000 was distributed as dividend. The reserve is estimated at 52,294 tons averaging 10·6 dwt. The rate of extraction has been decreased to 3,000 tons per month, and the mine will be exhausted in a year from the present date unless further discoveries are made. The directors are now considering the acquirement of another property, and already have one in view.

The reconstruction of the Amalgamated Properties of Rhodesia is proceeding satisfactorily. The majority of home shareholders have notified their intention to participate, so that the underwriters are freed. The new company is called the Rhodesia Exploration Company, and Messrs. H. G. Latilla, R. Sewell, and F. H. Hamilton are the first directors.

The Rhodesia and General Asbestos Corporation has been registered locally with a capital of £400,000, to acquire asbestos claims from the Charterland and General Exploration Company, and also the properties of the Victoria (Rhodesia) Asbestos company. The properties are regular producers and are equipped with plant. The company belongs to the same group (of which Mr. Edmund Davis is the leading spirit) as the Rhodesian chrome mines.

West Africa.—The yield of gold during June was worth £114,489, as compared with £121,104 in May, £127,107 in June 1916, and £135,289 in June 1915. The output at Abbontiakoon was less by £5,000, and that at Prestea Block A less by £1,500, as compared with the results for May.

The Nigerian Government recently offered for sale a number of mining leases on the Jarawa river, 25 miles east by north of Naraguta and a similar distance from Jos station, that had been developed by W. Mertens & Co., of Hamburg. These leases have now been acquired jointly by the Niger and the Rayfield companies. The document offering the properties for sale contained a lengthy report made in the early part of 1914 by Mr. W. Hessel for Messrs. Mertens. From this it appears that the tin gravels are distinctly promising, though ilmenite and rutile form the greater part of the concentrates. There is some reason for believing that the deposits are eluvial, and that the lodes may be discovered within the property.

Australasia.—Labour troubles are once more to the fore. The railway men are striking, and deliveries of coal are difficult and in places impossible. At the time of writing no solution of the difficulty is in sight.

The celebrated Bullfinch boom of the year 1910 promised great things, for the outcrop on the property, which is situated at Southern Cross, West Australia, led Sir George Doolette and his friends to hope that another Great Boulder had been found. Unfortunately the assay-values decreased rapidly in depth. During 1916, gold to the value of £76,860 was extracted from 71,360 tons of ore, as compared with £100,035 from 76,886 tons the year before. The profit was £9,966, out of which a dividend of 2½% has been paid. The ore reserve is estimated at 85,416 tons, a decrease of 11,918 tons during the year, the fall being due entirely to lack of labour. The northern series of lodes now provides most of the ore, but its grade continues to diminish. Winzes are being sunk from the 510 ft. level at points where the ore is most promising.

The Oroya Links and the Lake View & Star are two companies operating groups of mines at Kalgoorlie that are in the nature of "remainders." Under ordinary circumstances it was possible to make small profits, but the increase of costs and the scarcity of good labour have annihilated the small margin of profit. Both are managed by Messrs. Bewick, Moreing & Co. The first named suspended operations last August, and the properties were let to tributers. Lake View & Star is also in a precarious position, but the directors consider it best to continue operations at a loss, as the deficit involved will probably be less than the standing charges in case of a suspension of operations. There is no suggestion of letting the property to tributers. The yearly report now issued covers the period ended February 28. During this time, 187,823 tons of ore was treated, 90,346 tons coming from the Lake View, 84,681 tons from the Star, and 12,796 tons from the Chaffers. The yield of gold was worth £197,603, and the loss for the year was £5,755. The reserve at Lake View is calculated at 83,368 tons averaging 26s. 4d., and at the Star 268,123 tons averaging 25s. 11d. Economies are being made in administration and management expenses. The Chaffers is a recent acquisition. If the directors had anticipated the present financial position, they would not have applied funds in this direction.

Operations at the Great Fingall have been rendered difficult by the shortage and poor quality of labour. Some time ago we recorded that developments in depth did not warrant the sinking of the internal shaft to the 20th level. Since then a winze has been sunk below the 19th level, and at a depth of 172 ft. driving north and south has been done. Some measure of success has attended this work, and the prospects in the bottom of the mine have improved. The report for 1916, just issued, shows that from the resumption of milling in April to the end of the year 34,049 tons of ore was treated for a yield of gold worth £65,518, but the cost, including all expenses, was greater than this by £3,394.

India.—The Anantapur Gold Field company was formed in 1906 by John Taylor & Sons to acquire old workings in the Anantapur district, Madras Presidency. It will be remembered that, after development, the North Anantapur and Jibutil sections were sold to subsidiary companies, which have now been producers on a small scale for some years. The parent company has more recently been exploring the Ramagiri block. The report for the year ended March 31 shows that development has been continued, but that the results are disappointing owing to the low assay-values. Additional land covering half a square mile adjoining the North Anantapur property has been sold to the latter company. The accounts show an expenditure of £8,131 during the year, and an income of £618, the latter including £490 received from the holding in North Anantapur.

Burma.—The yearly report of the Burma Corporation and the chairman's speech at the shareholders' meeting (the latter reported at some length in our advertising columns) contain detailed reviews of the progress of this venture. The Tiger adit is being continued from the internal shaft of the Chinaman ore-body to the vertical-shaft section, and about half of the extra distance, 1,500 ft., has already been driven. The ore reserves have been increased 60% during 1916, as stated in the directors' report. Since the beginning of 1917, additional ore has been developed, and at the end of June the figure was 3,644,000 tons averaging 27·4% lead, 20·3% zinc, 0·5% copper, and 25·2 oz. silver per ton. The ore-body can be divided into zones in which the zinc content varies. At present the ore highest in lead is being smelted, and lead and silver are being produced. Eventually concentration, or rather separation of the sulphides, will give a better smelting material, and will moreover save the zinc for zinc-smelting operations latter. A concentration plant, having a capacity of 800 tons per day, is now on its way from America, and in the meantime tests are being continued. The fact that Mr. Wilton Shellshear is undertaking the concentration work is a distinct point in the corporation's favour. With the experimental plant, it is stated that the ore high in lead can be treated so as to produce a lead concentrate containing 80 to 85% of the total lead and 75 to 80% of the total silver in the ore, and at the same time containing not more than 30% of the zinc. In discussing the policy and progress of the corporation, it has to be remembered that capital cannot be raised for development and construction of plant by the issue of shares or debentures, and that all the funds have to be provided out of the mine itself. Under these circumstances the results obtained are decidedly gratifying.

Unfortunate rivalry of two groups of shareholders in the Southern Shan States Syndicate and its subsidiary, the Mawchi Mines, has led to unpleasantness at the meetings and in the Courts. Suffice it to say that the party in control, and constituting the boards, has won on a poll, and that the directors can now give their minds entirely to the real business in hand, that is to say, the production of tin and wolfram concentrates.

Cornwall.—The Levant mine, after passing through several unprofitable quarterly periods, was able to pay a dividend on the period ended June 30 last. The amount of tin concentrate produced was rather lower than the recent average, but this was due entirely to shortage of labour and not to any decrease in the quantity or quality of available ore. The mine is the only substantial producer of copper in the country, and though the output is only small the Government encourages the operations, seeing that every supply from a home source is of value nowadays.

East Pool £1 shares are to be split into four shares of 5s. each, for the convenience of present or intending shareholders. The £1 shares stand at a high premium, the latest figure being £2. 12s. 6d. The search for the East Pool's Rogers lode in the adjoining South Crofty ground continues, but still without result.

Malay. — The Chenderiang company was formed to operate a dredge and also to sluice certain ground. It has recently been found inadvisable for the company to do the latter work, and that part of the property has been let on tribute. Additional dredging ground has recently been acquired, and in all probability another dredge will be built.

Canada.—According to proposed legislation, an income tax of 4% is to be levied on joint stock companies. The labour position has been greatly improved lately, owing to the mine owners and the men coming together and reaching an agreement with regard to wages.

News comes from the Dome Mines at Porcupine to the effect that diamond-drilling has indicated the existence of a lode 120 ft. wide and averaging $17 gold per ton. A cross-cut on the 700 ft. level is being driven to intersect this lode. Until this is completed, everybody rightly keeps an open mind on the subject.

No technical information is given by the nickel-producing companies, and their yearly reports are of the baldest. The International Nickel Company of New York, that has such a large holding in the Sudbury district, gives no hint of the actual output of the metal, and such items as costs of production are most jealously guarded. During the year ended March 31 last the gross profit was $17,000,000, out of which $10,000,000 was distributed as dividend. The Mond Nickel Company reports a net profit of £327,248 for the year ended April 30, after payment of interest on £875,000 debentures. The dividends on preference and ordinary shares amounted to £248,600, and £50,000 was placed to reserve. The distribution was the same as that for the previous year. The Lorne hydro-electric power plant is being gradually extended, and the scale of operations at the mines and smelters is being correspondingly increased. Diamond-drilling has added greatly to the known ore reserves. The British America Nickel Corporation has commenced the building of its smelter at a point 4½ miles north-west of Sudbury. Here again the recent developments have disclosed large ore resources, and the operations are to be on a greater scale than intended at first.

United States.—As recorded last month, the labour situation in copper-mining centres has been most unsatisfactory recently. At the Clifton-Morenci district the men came out on strike at the beginning of July. Everything is quiet and no scenes of violence have so far occurred such as characterized the similar event in 1915, but the men show no signs of going back. The Arizona Copper Company is of course badly hit, with the others, but it is nevertheless able to pay an interim dividend on the result of the first half of its financial year, October 1, 1916, to March 31, 1917. For this period the profit was £779,877, obtained from the production and sale of 12,246 long tons of copper. The ordinary shares are now receiving £170,988, being 2s. 3d. per 5s. share. The company is still redeeming terminable debentures, representing capital subscribed when the mining and metallurgical operations were reorganized and extended.

Keen attention is being paid to potash recovery in the United States. According to Mr. R. J. Wysor, as quoted in our February issue, a substantial proportion of the potash in iron ore and fluxes can be recovered as soluble salts in the dust of blast-furnace gases. The dust of cement kilns is similarly valuable. Cottrell electrostatic dust-precipitators are now being extensively erected to catch this dust. The Alabama ores are particularly high in potash, and Mr. Charles Catlett estimates a recovery of 75 lb. of potash per ton of iron produced. At Baltimore, the Spar Chemical Co. is making potash salts by roasting felspar with salt cake and common salt. The Cushman and Coggeshall process yields chloride by treating felspar with quicklime and calcium chloride, the latter being the residual in the ammonia-soda process. In England, the value of the potash content of blast-furnace dust is fully appreciated. The Minister of Munitions has recently issued a notice instructing iron-smelting companies to save the dust.

Chile.—We give an outline of the position at the Poderosa copper mine in our section devoted to Company Reports. At the meeting of shareholders, the chairman announced that attention was being turned to certain tin deposits in Bolivia. If these come up to present expectations, the company will be on a better basis than formerly, for it has £100,000 cash in hand to spend on the properties. Probably the directors will write down the par value of the shares from £5 to £1, and then the nominal capital will be represented by assets of equal or greater value.

THE WOLFRAM DEPOSITS OF BURMA

By HARRY D. GRIFFITHS, A.R.S.M., M.Inst.M.M., M.Inst.C.E.

The author supplements the information given in his previous article, published in 1914, with regard to the output of wolfram in Burma, and he discusses the labour problems, the prospects of the lodes continuing in depth, and the chances of profitably working the detrital deposits. In a second article the author will describe the Kanbauk lode mine.

INTRODUCTORY.—In the issue of the Magazine for June 1914, the writer gave a short description of the young but promising wolfram industry of Lower Burma. Those were the days before the war. Since then, and owing mostly to the largely increased demand for tungsten steel for munition manufacture, wolfram mining has assumed a great importance. As wolfram is not a widely distributed ore, its occurrence and mining are not generally known, and a few notes thereon, and on one of the leading British wolfram mines, may not be considered out of place at the present time.

Until a few years ago, the demand for wolfram was small, and the world's output was not an important one. Statistics of past production can only be obtained with difficulty, and are not always accurate, while literature on the subject of wolfram mining is practically non-existent. The advent of tungsten steel has created an increased demand for the metal, and has gradually stimulated its mining exploitation in different parts of the world, outside of Europe. For many years Europe was capable of supplying its own needs, mostly from mines in Spain, Portugal, and Germany. The Cornish mines at all times yielded comparatively small quantities of wolfram, occurring merely as an impurity of the tin ore. At first this was almost invariably got rid of at the earliest opportunity, and often thrown away on the waste heaps. Magnetic separation gradually induced the miner to look upon wolfram as being of some value, and the present Cornish production is not a negligible quantity. Nowadays, some of the mines are being reopened for the special purpose of producing wolfram.

WORLD'S PRODUCTION.—Such statistics as are available would tend to show that the world's production of wolfram and other tungsten ores such as scheelite, has been approximately as given in Table I. in the next column. It is estimated that, during the year 1916, the British Empire must have produced close upon 50% of the world's total output of wolfram.

TABLE I.—WORLD'S PRODUCTION OF TUNGSTEN ORES IN METRIC TONS.

	1911	1912	1913	1914	1915	1916
United States	1,173	1,152	1,397	900	1,970	
F.M.S. and Siam	182	108	281	30	340	
Australasia	1,147	1,268	752	800	825	
Burma	1,106	1,520	1,530	1,653	2,144	3,077
England	267	192	182	205	250*	
France	171	230	245	300*	300*	
Austria and Germany	126	167	150	220	400*	
Portugal	980	1,330	800	967	1,400*	
Spain	96	169	150	84	150*	
Japan	24	205	297	195	240	
Argentine	584	638	539	394	600*	
Bolivia	297	477	564	832	600*	
Peru	52	214	300	130	250*	
Totals	6,105	7,670	7,107	6,650	8,469	

* Estimated.

TABLE II.—PRODUCTION OF WOLFRAM IN BURMA.

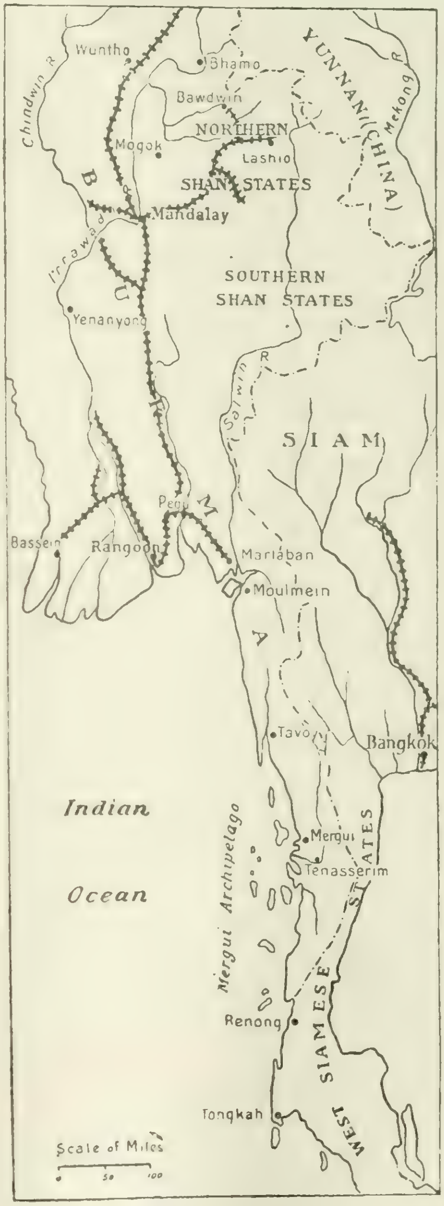
	Tons	% of World's Production.
1911	1,091	18·1
1912	1,499	20·0
1913	1,509	20·8
1914	1,631	24·8
1915	2,116	25·3
1916*	3,035	36·0

* Estimated.

WOLFRAM IN BURMA.—The existence of wolfram in Burma has been known for many years, and the occasional exploitation of deposits was for a long time in the hands of the local natives. It gradually drew the attention of some Chinese and also Europeans, until the year 1909, when the first official report of output, 354 tons, was published, and when the first prospecting license for wolfram was granted by the Government. The output increased with great strides until, as shown by Table II., Burma has established itself as the world's leading producer.

Since then it has never looked back, and although it cannot be expected that the ratio of yearly increase will be kept up, yet for many years to come Burma will remain a producer of some importance. Since the beginning of the war, or at least since the English Government decided to take over the total production of Burma at a rate which remunerates the producer (55s. per unit of WO_3), the production has been stimulated, and has indeed been urged by all possible means, even by the threat of possible drastic measures. As will be shown later, the number and nature of the deposits have readily lent themselves to a great spurt in the production. The Government of Burma has given assistance in the shape of importing some of the necessary Chinese labour to work the mines. The present policy is one of necessity, its paramount object being to produce as much wolfram as possible at once. This is in many cases being done regardless of the future of the mines, and the writer would take this opportunity to urge the Government to consider seriously the development of the properties ahead of immediate requirements.

What may be the position of wolfram at the end of the war, none can predict. The market may become subject to violent fluctuations in price, the demand for wolfram will almost certainly decrease, and as far as Burma is concerned the cost of production will assuredly increase enormously, when the wolfram has to be looked for in depth instead of being mostly quarried at the surface. The only condition which would probably prevent violent fluctuations would be a continuance of the practical monopoly of the metal by the home Government, such as exists at the present time. It is thought that if the export of tungsten ores from British colonies or dependencies to any country except England were prohibited, a good hold would be secured on probably half the world's output, and the United Kingdom would be assured of its requirements. The chief consumers of tungsten produce practically none in their own country, and would become dependent to some extent upon the British product, because it must be remembered that for many reasons countries like Spain and Portugal, Bolivia, etc., are not likely to keep up their lately inflated output. The metallurgical treatment of tungsten ores is now almost entirely in British hands, and is likely to remain so for a long time. In any case it is to be hoped that the British Empire, being capable of producing half the world's output of tungsten ores, will not allow the control of that industry to pass into foreign hands as in the past. In this connection it may be well to recall what took place some years ago in the Federated Malay States when an attempt on the part of some American interests to secure more than 40% of the world's output of tin was frustrated by the imposition of an absolutely prohibitive export tax on tin ore shipped to any country but the United Kingdom. The wolfram miner is at present doing very well, but is not without some misgivings as to what the Government may do after the war. He is, however, hoping that the British industry will remain British controlled in every respect, and that some attempt will be made to prevent violent fluctuations in the price of metal and consequent disorganization of the industry.



Map of Burma.

Labour in Burma.—Although Burma has so greatly increased its production, it is evidently not yet satisfying the needs of the Government, who are pressing for a further considerable increase. How this is to be achieved is not yet evident. At a recent meeting of the producers and the local Government at Tavoy, it seems to have been decided that the only way to obtain a larger production is to secure more labour. It is notorious that in the matter of labour Lower Burma has always been badly off. The local native cannot be depended upon, as he has not in him the making of a miner or a steady labourer, and he will only work for short periods when it suits his convenience, nor does he take notice of any time engagement he may contract for. When he wants a change he goes generally without notice, and often without troubling about any moneys that may be due to him. A certain number of Tamils or Southern Indians are available for general surface work, but they are unsatisfactory for quarrying or mining. Being scattered about in small numbers in the mining districts they do not show that tendency to settle down which is characteristic of them when in large numbers and under fair treatment and conditions. The other class of labour consists of Chinese coolies who have gradually worked their way up from the Malay Peninsula or Siam, or who have recently been imported therefrom by the Government. Though still in inadequate numbers the Chinaman appears to continue to be the mainstay of those mines when anything approaching mining work is being done. He is not an ideal miner, however, and does not take too kindly to hammer and drill work. He is much given to the roaming habit, always in search of variety or some less arduous task, or a chance of a place where he can work unfettered on his own. The ease with which he can at the present time command a high wage (the average wage is 1 rupee 12 annas, equal to one Straits dollar or 2s. 4d.) makes him independent, and he certainly does not give the same amount of work as his countryman in the Malay States. He prefers contract work to any other arrangement, provided the work suits him and he is allowed to pursue his own methods of work. The imported coolie is supposed to be under contract to work for 300 days wherever he has been placed, but, as the Government has apparently no power to compel him to work, he sometimes eludes his obligation to his employer.

If it is definitely the intention of both the mine owners and the Government to depend upon the Chinese coolie for the exploitation of the mines, some drastic measures will be needed, and either the indentured or the registered system will have to be adopted.

In the first case the importation should be entirely under Government control; the time contract should be for a longer period than 300 days; repatriation should be compulsory after the contract time, unless the coolie chooses to re-engage for a further period; and, above all, the Government should be vested with full powers to compel the labourer to fulfil his contract, to punish delinquents, and to deport. Provisions should be made to deal with crimping, and the proper care and housing of the coolie. A uniform rate of wages lower than the present one should be fixed for all imported coolies, latitude being, however, left to the employers, with the approval of the Government, to give work on contract, or bonus, or give a higher wage in the case of those showing special knowledge or aptitude.

Under the registered system, every Chinese coolie in the country should be compelled to register, and should be furnished with a pass on which would be entered full particulars of dates and the nature of his employment. Such passes should be renewed annually. Newcomers should be compelled to work for so many days in the year under a penalty of deportation. The coolie should be make to come under the same obligation as the European as regards giving notice to leave. The passes should be available only for one particular district, so as to avoid the gradual dissemination of Chinese throughout the country. All these measures are drastic, and their adoption would require some courage on the part of the Government, inasmuch as the present tendency is to do away, throughout India, with the indentured system that has been in vogue for such a long time. The writer is convinced that, without such measures, for a few years to come at least, until there is a sufficiency of mine labour, no satisfaction will result from the employment of that class of labour.

The Chinese coolie will not freely flock to the mines, as is the case in the Malay Peninsula, for the reason that in Burma he will not get those opportunities that characterize Malaya of working little patches of ground on his own and becoming his own master, with always a chance of finding further speculative work.

The indentured system has now completely ceased in Malaya. Labour there is plentiful and free, and this is solely due to the fact that the Government for many years countenanced and assisted indentured importation until the country was fully provided with its need. The Government of Burma could with great advantage follow the precedent of Malaya as regards the Chinese, and would no doubt secure most valuable information on the subject from that country. Or else it might copy, with small alterations to meet local needs, the conditions under which, some years ago, Chinese coolies were imported into the Transvaal. This latter experiment conclusively proved that an ordinary coolie without any particular previous training was capable after a short time of becoming a very efficient underground miner, and that under firm but benevolent rule he was easily managed and controlled.

Another solution of the mine labour problem could, perhaps, be obtained in another direction, namely, the importation of labour from the mining districts of Central India. That labour, although perhaps not as strong as could be desired, nevertheless gives satisfaction in those districts, and it has a character of permanency which is greatly desirable in mining centres. It could be obtained quickly in sufficient numbers, provided the conditions were made easy, and a chance was given to it to settle permanently in the country. This could be accomplished by the creation, on the different mining concessions, of permanent reserves, where the coolie would be allowed to hold a little plot of land, provided he had given a certain amount of work in the mines. He would be induced to bring his family over, and make a permanent home for himself, thereby creating a steady reliable mining community. The climate of Lower Burma is eminently suitable for the settlement of Central Indian natives, who would find it less exacting and probably healthier than their own. The suggestion is well worth the consideration of the local Government, who no doubt would receive the greatest assistance from the Indian Government. Unless some of the alternatives suggested by the writer are adopted, it is certain that the wolfram industry of Burma will be always seriously handicapped by the want of suitable labour and high costs of working, and this may eventually lead to the impossibility of competing against other producing countries, and perhaps render unproductive an extensive source of wealth.

Lode Prospects in Burma.—If reference be made to the writer's previous article in these columns, in June 1914, it will be gathered that the wolfram lodes are numerous and extensive, and give indications of permanency in depth. There should therefore exist in Burma a prolific source of wealth, and that country should be destined to take and maintain the lead in the world's production of wolfram. Although a vast amount of work has been done during the last few years, such work has been mosly confined to the outcrops, and has not extended to any great depth. In other parts of the world, the work on purely wolfram lodes has seldom reached the undecomposed zone, and very little seems to be known as to what may be expected in depth. Most of the wolfram outcrops of Burma show the presence of a small percentage of cassiterite, with occasionally a little bismuth and molybdenite. No geologist has given an opinion as to what will happen in depth. The wolfram may persist or it may gradually be replaced by cassiterite or other minerals. This is a point of importance. If the wolfram is replaced by cassiterite, or if the proportions in which they now occur are reversed, no great harm will have happened, and Burma will be a tin producer instead of a wolfram producer. On this point the writer has not been able to obtain any evidence. What causes some doubts in the minds of miners is that wolframite is not of the same stable nature as cassiterite; that, being presumably more volatile, it would have been deposited in the lodes after the cassiterite, and would therefore not be found in depth. As regards this, it is only necessary, in order to prove the permanency of wolfram in depth, to point to the Cornish mines which still find some at a depth of nearly 2,000 ft.

In Cornwall, copper and then tin formed the chief mineral constituents, and the conditions of the deposition must have been quite different from those of the wolfram deposits of Burma, where copper and cassiterite occur only as minor impurities to the chief mineral. It is unfortunate that so little evidence as to the behaviour of purely wolfram deposits in depth should be procurable. Outside of Burma, the writer has only heard of one case where, at a depth of 360 ft. from the surface, and therefore well inside the undecomposed zone, a wolfram lode only showed a change of its characteristics in the shape of increased values in wolfram, and the addition of a small percentage of copper pyrites and molybdenite. In Burma, the writer has seen, in two instances only, the apex of the undecomposed zone of the lodes, and at both the points the percentage of wolframite was greater than the reef had yielded in the undecomposed zone immediately above it. Iron pyrites (with very little copper pyrites) were in slightly increasing proportion, and bismuthine, cassiterite, and molybdenite were also present in small quantities. These two instances may not be sufficient to form a conclusive evidence, but in the absence of adverse facts, they may be considered as a hopeful sign for the future in depth of the Burma lodes. The importance of securing geological evidence as to the probable behaviour of these lodes in depth does not seem to have struck the Government of Burma as being urgent, and, as far as the writer knows, no inquiries in that direction have been made by the Government geologists. A thorough inquiry by an experienced geologist, backed by a practical knowledge of mining, would be invaluable to the mining concessionaires and would be of great assistance in securing, at a later period, the large amount of capital which will be needed to open up the deposits in a workmanlike fashion.

The writer has seen most of the important wolfram lodes of Burma, and from evidence gathered, and from the quantity of ore now being extracted, has come to the conclusion that the decomposed zone of the lodes carry high remunerative values. They also carry blank or poor patches like all the similar deposits, but the richer portions are sufficiently good and extensive to make a good average. As an instance can be mentioned the case of a number of lodes having been mined to a depth exceeding sometimes 150 ft., and the ore being milled after a small amount of sorting had been done. The work extended over five years, 34,000 tons being milled for a return of 42 lb. per ton. The rejected dumps on testing proved to have a value of 11 lb. per ton, and were eventually crushed in the mill at a profit. The tailing, owing to shortage of water and imperfect concentration, assayed from 7 to 8 lb. per ton. Some lodes in Burma will assuredly yield more than the value above quoted, and so far as is known few lodes have proved entirely barren. In another case that came under the notice of the writer, 1,000 tons of quartz, obtained by driving on five lodes, on being roughly sorted and hand-crushed, yielded 50·4 lb. of wolframite per ton.

Most of the mineralized zones containing the wolfram lodes occur in hilly country, and can therefore be partly exploited by means of adits and cross-cuts. But it is not often that the crest of the hills is sufficently high to permit a cross-cut or level at the deepest point to enter the undecomposed zone. This zone will probably not be fairly reached until a depth of 250 ft. below the outcrop has been obtained. Above that depth only the highest peaks of the zone may be obtainable. It follows, therefore, that a great amount of deep work will be needed before conclusive evidence of the behaviour of wolfram in depth is secured. This evidence might in some instances be obtained by means of bore-holes, but, owing to the high fluctuating values of the lodes from point to point, evidence so secured would probably prove extremely misleading. So far, the work has been practically confined to the quarrying of the outcrops and the driving of a few adits or cross-cuts at a shallow depth, followed almost immediately by stoping. It cannot be said, therefore, that any real development, or the creation of substantial ore reserves, has taken place. The work has been of a hand-to-mouth nature, with little consideration for the future. With one or two exceptions, no proper mining work has been done, and in those exceptions there is but little ore properly blocked out. The present policy is to keep stoping as fast as the drives advance so as to produce as much wolfram as possible, and to undertake no permanent development in order to keep the mines working at a later period. This class of work, considering the large number of outcrops and their value, can for some time yield an important output, but it is highly detrimental to the future of the industry. The outcrops are easily worked out, but their life must necessarily be a short one, and when proper mining work is required, it will be found that no provision in cash or otherwise has been made therefor. The time must come soon when proper mining in depth will be essential, when the production will fall rapidly, and where large sums of money will be required to make mines of the present prospects and equip them. The local Government is making an effort to induce the recent concessionaires to undertake a certain amount of development, but that development is apparently no more than is absolutely needed for immediate stoping operations, and cannot rightfully be called by that name. It is also evident that, under the mining concessions so far granted, the Government has no power at all to compel the holders to devote the needed nine-tenths or thereabouts of their present profit to effective development. It follows that, in the immediate future, a large amount of new capital will be required to keep the industry going. So far, the small amount to make the outcrops yield a profit has been subscribed locally, and during the last two years exceedingly good profits have been secured, and the local subscribers have every reason to feel satisfied with their ventures. No doubt they will prefer to pass over their property to foreign capital, on the strength of their past surface results. They reckon rightly that, after the war, plenty of money will be available in the United Kingdom for likely mining enterprise abroad, but they must not forget that British capital for such purposes is very shy, and only obtainable when it can secure some solid prospect, a sound title, and an assurance of security and non-interference. The absolute dependence of Burma to the Indian Government, the difficulty the former has of securing from the latter the money needed for the proper opening of communications or other facilities needed in the mining districts, the nature of the mining titles which render them liable to cancellation without power of appeal to a court of law, the uncertainty as regards the amount of royalty to be paid, and many other small but important details, will all undoubtedly prove serious checks to the inflow of British capital, or may possibly frighten it away altogether. It therefore behoves the Government of Burma, if the potential wealth of the country is to be profitably exploited, to place every inducement in the way of foreign capital, to thoroughly revise the mining laws and mining titles, and to do away with the sundry minor vexations to which holders of titles and miners have often been subjected. The authorities must convince themselves that, without the raising of a lot of capital, the great asset which they possess will not become realizable.

The writer hopes that this appeal to the Government of Burma will not remain unheeded, and that some good may come from it, but it must be remembered that a Government alone cannot make a mining district. A great responsibilty rests also with the adventurers themselves, and they should be given a word in season. As has been already said, they are taking every possible advantage of a very fair price for their product, and of Government help in the shape of imported labour. They are mostly inclined to let the future look after itself. Few of them realize the amount of cash that will soon be needed to place their property on a permanent basis. They seem to believe that when they have worked out their outcrops they will be able to sell their property with no showing other than its past results. It is during a period of prosperity such as the present that they should devote a large portion of their profit to sound and permanent development in depth, and to the formation of a reserve fund for future equipment.

ALLUVIAL PROSPECTS. — It has already been stated that there exists practically no true alluvial deposits in Lower Burma. Shed wolfram, however, and, in some cases, cassiterite, occur extensively in all parts of the district, in the rocky beds of the creeks and in the talus found at the foot of hills carrying the mineral lodes. These deposits are invariably alluded to as "alluvials" in the district. They carry wolfram in diminishing quantities, as they spread away from the hills. The values are extremely variable from point to point, but as a whole, provided that water is obtainable, they are capable of being worked profitably. In very few places are the beds of the creeks wide enough, and flat enough, with sufficient thickness of deposit, to make them suitable for suction or bucket-dredging. These creek flats generally contain mostly cassiterite, the wolfram which accompanied it having presumably become weathered or ground away before it could reach the spot. In all the wolfram alluvials that mineral is found in the coarse state, often with quartz from the veins from which it has been derived adhering to it.

A great amount of work has been done, mostly during the rainy seasons, upon these alluvials, which until recently must have been answerable for 33% of the country's output. Their steady and profitable exploitation will depend entirely upon water being available in their vicinity throughout the year, and upon the use of suitably designed pumping plant. Their value under reasonable conditions of occurrence and cost of pumping appears to be remunerative, but before exploitation is undertaken, great care should be exercised in considering all the conditions of quantities, values, cost of plant, cost of pumping, etc. A liberal allowance should be made all round in the last items. Few of these properties have as yet been equipped for work on a large scale, although an excellent lead has been given by a few enterprising companies.

There would appear to be only two practical ways of working these deposits, if we do not take into consideration the very few cases where large quantities of water have been impounded in reservoirs, sufficient to work monitors. An instance of this will be detailed later.

The first method applies to such properties where a high lift of water is unavoidable. In this case a simple pumping plant is secured just to lift the water to the top of the working face, where it assists the breaking down of the ground by picks or crowbars, and is sufficient to wash it in ground or other sluices. The method has a small capacity and requires high values in ore to make it remunerative, but in many cases it is the only practicable one.

In the second method, where the required lift is small, pumps are used to force the water under pressure sufficient to work monitors. By this means labour is saved and a much greater yardage can be dealt with. Taken all through, the majority of the alluvial deposits will not bear the expense of a pumping plant and its high working cost, but they will be capable of being worked profitably during the rainy seasons, provided that some provision is made for the proper diverting and channelling of the rain waters.

The alluvials are capable of yielding an important output for many years to come, and at a much cheaper rate per ton of wolfram obtained than can be possible from lode mining. The great drawbacks of any pumping or mechanical installation in Lower Burma are the difficulty of securing and transporting wood fuel, the inferior quality of wood allowed by the Forest Department to be used as fuel, and the difficulty and high cost of transporting other kinds of fuel.

WATER AND WATER RIGHTS.—There are unfortunately very few waterfalls or likely spots where rain waters could be stored in sufficently large quantities to yield a constant and steady power supply, and the Government is generally reluctant to give concessions for the use of the few opportunities that occur. Some such spots are, however, available and might to some advantage be studied by the Public Works Department, with possibly a view to the installation of a Government power-plant. The Government is rightly reserving all water rights, the use of which they grant only under very good reasons, but unfortunately the conditions of the grants are of such a nature as to make their tenure somewhat insecure. These grants should be absolute, and of such a character as to render them unattackable by any subsequent claim on the part of any one, and liable to cancellation only by order of a High Court of Justice.

OTHER QUESTIONS.—There are many other minor points in connection with mining that are either vague or unsettled, and which require immediate attention. For instance, when a mining concession has been granted for a number of years, it is understood that the authorities will offer no difficulties to its renewal; but there is an uncertainty as to the terms on which such a renewal will be granted. There is no guarantee that when a mine has made large profits the Government may not require a high premium for such renewal or may want to dispose of it to the highest bidder.

The stealing of ore, which at the present time is so flourishing, should be inquired into, and provisions should be devised to check it. The granting of licenses to buy ore should be done with great care, should be under careful control, and subject to drastic restrictions. The opening of means of communication with the outside districts should be pushed on more actively than has been the case so far. The housing of mine labourers and the care of their health should be under official control. A detailed geological survey of the principal districts, with a special study of the lodes themselves, would be of great value to all concerned. It may be argued that all these matters will be gradually attended to in the course of time, when the industry develops, but if the Government is convinced of the future of the wolfram prospects, there should be no reason for the withholding of assistance, improvements, and facilities, and advantage should be fully taken of the experience gained in the other mining districts of the world.

The Aluminium Co. of America.

As is the case with most close corporations in the metal trade, the Aluminium Company of America publishes practically no information as to its operations. The Boston News Bureau has recently issued a statement giving a few facts, which we quote herewith. During 1916, the receipts were $25,940,427, from the sale of 38,656 long tons of aluminium, the sale price averaging 29·96 cents per lb., or about £140 per long ton. In addition 11,080 tons of aluminium was delivered to a subsidiary for the production of various aluminium manufactures. The share capital of the company is $20,000,000, and there are about 300 shareholders, many of them employees. The late C. M. Hall, the inventor of the smelting process, owned $5,000,000 in shares in the company. From 1889 to 1898, the capital of the company was $1,000,000, and the only dividends paid were 4% for 1895 and 6% for 1896. From 1899 to 1904, the capital was $1,600,000, and the yearly dividends were 4½, 8¼, 7¼, 8½, 7¼, and 6% respectively. From 1905 to 1908 the capital was $3,800,000, and the dividends averaged 10%. In 1909 the capital was raised to $20,000,000, and for the next four years the total dividends were 4·2%. For 1914, 1915, and 1916, the dividends were at the rates of 6, 6½, and 10%. The company has a yearly capacity of 75,000 tons. With no imports since the outbreak of the war, the company has been called upon to furnish the entire requirements of America, whereas formerly 40% of the American consumption was imported from France and England. For 1918 delivery the company has quoted 37c. per lb. as its price, although some sales have recently been made at as high a price as 60c. per lb. Though the nominal capital is $20,000,000, the company has a plant investment of over $80,000,000, approximately $70,000,000 of undivided profits having gone back into the property.

LATERITE:
ITS ORIGIN, STRUCTURE, AND MINERALS.

By J. MORROW CAMPBELL, B.Sc., M.Inst.M.M., F.R.G.S.

The author has made a close study of laterite for many years, and has lived in countries that provide unrivalled opportunities for observation. As the article will extend through several issues of the Magazine, a summary of his conclusions are given at the beginning, so that the aim and object of the arguments shall be fully grasped by readers.

SUMMARY.

The "alteration" of crystalline rocks is more rapid and intense in warm than in cold climates, but the results in every climate are fundamentally the same, differing only in degree. The final result of alteration is mostly hydrous silicate of alumina. The "weathering" of rocks proceeds much more slowly in warm than in cold climates, mainly on account of frost, but the ultimate results are similar. (Definitions of the words in quotation marks are given on page 72). Crystalline rock, either altered or unaltered, is not transformed into laterite in any country while it is either out of contact with atmospheric air or out of contact with vadose water. (Laymen are referred to the definition of "vadose" on page 70). Unaltered or impermeable rock is incapable of being laterized.

Laterization is the process by which certain hydroxides, principally those of ferric iron, aluminium, and titanium are deposited within the mass of a porous rock near the surface. Unless a rock formed near the surface contains uncombined alumina in the form of hydroxide it cannot be regarded as lateritic. Lateritic constituents are deposited in porous rocks between maximum and minimum vadose water-level only in places where that level is near the surface and oxygen can gain free access. Lateritic constituents are believed to be deposited in limited quantity in suitable situations in temperate climates. Rock, at the time laterization commences in it, usually contains no iron. The rate of formation and deposit of lateritic constituents appears to increase directly with the temperature.

Iron is primarily deposited in laterite as amorphous, highly-hydrated ferric hydroxide, formed by the atmospheric oxidation of ferrous salts, principally carbonate, in solution in vadose water. This hydroxide is often converted into almost or quite anhydrous ferric oxide by means of the simultaneous action of heat and water acting continuously.

Alumina is primarily deposited in laterite as the amorphous tri-hydrate, which may be mixed (or possibly combined) with ferric hydrate, in which case segregation partial or complete into gibbsite (Al_2O_3, 3 H_2O) and ferric oxide usually takes place. Alumina in laterite is derived from hydrous silicate of alumina, which is believed to be broken up by alkaline water producing alkaline aluminate and silicate; this action may be reversed. Alkaline aluminate decomposed by carbonic acid yields amorphous tri-hydrate of alumina; so also does the spontaneous decomposition, but under favourable conditions the latter yields gibbsite. Water from the laterizing zone when exposed to the air deposits ferric and aluminium hydrates with hydrous silicate of alumina, all amorphous. An aqueous medium from which lateritic constituents can be deposited is capable of redissolving them.

Secondary change in laterite usually tends toward complete hydration of alumina and complete dehydration of ferric hydrate, usually also toward removal of iron, with a consequent increase in the percentage of alumina and the production of aluminium ores commercially known as bauxite. When amorphous tri-hydrate of alumina is approximately pure it suffers dehydration under favourable conditions, yielding an amorphous di-hydrate. An amorphous aluminium mono-hydrate has been found in old pisolitic laterite. Ancient laterites which, owing to geological movements, have passed below water-level have their iron leached; most bauxites of commerce originate in this way.

The composition of laterite is rarely if ever static. It may overlie almost any form of rock, and the ratio of its lateritic constituents is not dependent in any way upon the composition of the rock, which originally occupied the same place and from which it is commonly said to be derived.

CHAPTER I.—INTRODUCTION.

THE AUTHOR'S OPPORTUNITIES OF STUDY.—In commencing this article on laterite, it is only right that I should record that I have enjoyed exceptional opportunities for studying the surface decomposition of rocks in the tropics, and more especially in Africa, in connection with the testing and working of auriferous and stanniferous alluvials, and prospecting in general. Observations were commenced nearly twenty years ago, and the work has been followed since, as opportunity offered, during a residence for twelve years in Africa. The parts of Africa visited were Sierra Leone, Liberia, Côte d'Ivoire, Gold Coast Colony, Ashanti, Guinée Française, Haut Sénégal et Niger, Sénégal, Northern and Southern Nigeria, Rhodesia, and Congo Belge. Several months were spent in Western Australia among the "breakaways," and several bauxite deposits in America were examined in 1915 and 1916. A considerable number of typical Indian and Ceylon laterites as well as South American were studied; the latter were from the Guianas and Brazil.

The study of the action of natural agents on rocks near the surface should be conducted by inductive and not deductive methods. General principles must be arrived at by the patient collection of facts by observation. To commence with a theory and select facts which support it may serve in the study of igneous rocks, where natural processes operate under conditions unknown and probably unascertainable and in positions utterly inaccessible, but it is wrong in the case of surface processes where every operation may be observed, and the truth thus established.

I have endeavoured to trace the various changes in the order in which they take place in nature, whereby a crystalline rock becomes a typical laterite, that is to say, essentially a mixture of ferric, aluminium, and titanium hydrates. When unsolved problems have been encountered they are plainly stated. No assertion is made that is not considered to be abundantly warranted by observation or experiment. All the conditions surrounding the occurrence and formation of laterite have been observed personally, and on these observations conclusions are based. At the same time due weight has been given to the observations of other geologists, who are freely quoted. It has been considered that a critical review of the older theories of laterization, while useful in many respects, would have occupied an amount of space quite out of proportion to its real value and would have involved much repetition. Criticism has been confined to only a few of the most recent articles on the subject. Among these that of Professor Lacroix on the laterites of French Guinea[1] must be given the foremost place. This work includes a wealth of observation and displays an honesty of purpose to which one cannot pay too high a tribute of praise. His observations are quite in agreement with those of the writer, and even give valuable support to conclusions at which Prof. Lacroix himself would probably have arrived had he enjoyed more ample opportunities and a longer time for studying the problem.

METHODS OF STUDY.—It is advisable to outline briefly the methods of study practiced, as the conclusions arrived at are in some respects novel. All the work involved has been done entirely by the author. Since field observations as well as analytical, microscopic, and experimental work have extended over a number of years it is impossible within reasonable limits to do more than summarize the results.

(a) Field Work.—The process of laterization was localized and observed in actual operation as often as possible. Lateritic material, especially free alumina, was searched for as a product of the weathering of rocks in such as had been exposed for long periods to various influences above water-level. Samples of the ground-water were repeatedly taken from below lateritic beds in course of formation, and examined. The precipitates produced by oxidation of this water were analysed. The thickness of dead laterite beds was measured whenever possible; samples were taken as well of kaolinized rock below. The relation of earlier to later beds, which are frequently found in terrace-like succession, was carefully studied. Rainfall records were kept, and the relation between total rain and the amount absorbed by the soil considered.

(b) Laboratory Work; (1) Chemical Analysis.—The necessity for knowing the composition of laterite is fully realized, but too much importance has been attached in the past to the percentage composition (carried to the second place of decimals) of a small "sample" taken from a big deposit. Repeatedly there have been found great differences in the composition of two such "samples" taken close together from the same bed. If accuracy regarding composition is demanded, corresponding care should be taken in securing a fair sample. The sampling of a laterite bed in order to ascertain its average composition would be a serious undertaking; it is rarely, if ever, done properly, and consequently the value of many laterite analyses that have been published is very problematical. For laterite analyses to have any real value the sample should be representative and also properly analysed.

As regards methods of analysis, an example must be quoted in which the work was wrongly performed, since, on the results obtained.

[1] A. Lacroix. "Les laterites de la Guinée et les produits d'alteration qui leur sont associés." Extrait des Nouvelles Archives de Museum, 5m. Serie, Tome v., 1913.

certain definite conclusions were based. These conclusions were accepted as reliable by many geologists, and have gained an amount of publicity to which they are in no way entitled. They were used against myself on a previous occasion.[2] I refer to the results of analysis of diabase laterite from Guinée Française, published by M.M. Chautard & Lemoine.[3] Prof. Lacroix[4] informs us that these analyses were done by the fusion method, and he says they have very little value. He also says,[5] referring to analyses in general, that such as have been done by fusion should be proscribed.

It is evident that in analyses done by the fusion method it is impossible to separate lateritic from non-lateritic constituents. The case of silica is most important. It may exist in laterite in five forms: Free: (1) quartz, (2) colloidal silica; Combined: (3) liberated by HCl, (4) liberated by H_2SO_4 and not by HCl, (5) liberated only after fusion with alkaline carbonate. It is imperative that free and combined silica be estimated separately, and for purposes of study it is advisable that all five forms be looked for and estimated if present.

As a concrete example the results of analysis (adjusted to 100·0) of a Northern Nigerian silicious laterite done by proximate methods are given below, and also the results by fusion. In each case the interpretation on a rational basis is attached.

PROXIMATE METHOD.

SiO_2 Free	21·2	Quartz	21·2
SiO_2 Combined	5·3	Kaolinite	12·2
Al_2O_3 19·9 Combined	4·5		
Free	15·4	Alumina	15·4
Fe_2O_3	36·7	Ferric Oxide	36·7
TiO_2	1·1	Titania	1·1
H_2O	15·8	Water	13·4
	100·0		100·0

FUSION METHOD.

SiO_2	26·5	Free Silica	2·8
Al_2O_3	19·9	Kaolinite	54·2
Fe_2O_3	36·7	Ferric Oxide	36·7
TiO_2	1·1	Titania	1·1
H_2O	15·8	Water	5·2
	100·0		100·0

The fusion method shows no free alumina, and the ordinary interpretation of the result would make the mineral a ferruginous clay. The proximate method shows only 5·3% combined silica, which leaves 15·4% free alumina; this, with over 20% quartz, shows it to be a quartzose laterite.

[2] Trans. Inst. M.M., Vol. xix., pp. 444–6.
[3] C. R. de l'Ind. Min., Feb. 1908.
[4] Op. Cit., p. 291.
[5] Op. Cit., p. 269.

The object aimed at in the quantitative analysis of laterite must be to ascertain the percentage of the various minerals present and not the percentage of elements only. Present analytical methods do not permit us to separate accurately crystalline aluminium hydrate from amorphous forms or the latter from one another. To complicate matters further we are faced with the suggestion[6] that there exists a hydrate of alumina containing more water than gibbsite. The amount of iron present in laterite is very easily ascertained, but analytical methods do not inform us as to the condition of hydration in which ferric oxide is present, so we cannot ascertain in this way what iron minerals are present in laterite save in a few exceptional cases.

The other important lateritic constituent is titanium, and here again analysis fails to give us satisfactory data whereby to ascertain the form in which it exists in laterite.

We thus see that quantitative chemical analysis alone is incapable yet of giving us adequate information regarding the constitution of laterite. The results it yields are often of less scientific value than intelligent qualitative tests combined with microscopic work. Before laterite analyses are worth serious consideration, we should know that the sample was properly taken, what it represents, and have the assurance that the analytical methods used were such as to permit of lateritic constituents being correctly estimated; otherwise results may be misleading, and therefore worse than useless.

The quantitative determination of water in small selected quantities of apparently pure minerals proved useful. Frequently hours were spent in collecting a fraction of a grain. Quite satisfactory and concordant results were obtained in this way, which proved beyond question the identity of certain minerals when no other method would have yielded even approximate results. Weighings were done on a delicate assay balance.

(b) Laboratory Analysis; (2) Microscopical Study.—The importance of the microscope in the study of the structure of laterite cannot be exaggerated. The study of the process in its early stages involves the preparation of sections of very friable material, largely hydrous silicate of alumina, often containing particles of quartz. It is essential that sections be prepared so that the relative position of the various parts as they exist in nature is preserved. With such material ordinary methods of har-

[6] D. C. Wysor. "Aluminium hydrates in Arkansas Bauxite Deposits." *Econ. Geol.* Vol. xi., No. 1, 1916.

dening often failed completely. Protracted heating of such hydrated rocks is obviously objectionable, so a new method was devised which was more rapid and was successful in every case. The method may thus be described: A small beaker of Canada balsam is heated until of the correct consistency. The specimen to be hardened is warmed, after air-drying, and submerged in the liquid balsam, which is at once placed under the bell-jar of an air-pump. The air is rapidly exhausted, and in this way is removed from the pores of the specimen. As soon as bubbles cease to be given off, air is re-admitted to the bell-jar. The beaker is removed and the balsam kept liquid for some time so as to allow it to thoroughly fill the pores. The specimen is taken out while hot, and when cold is ready for cutting. Material such as altered or weathered granite is specially hard to deal with, and it is only by exercising the greatest care that sections under 0·05 millimetres in thickness can be obtained. Thick sections are practically useless.

Thin sections of highly gibbsitic laterites, usually very porous, are apt to be imperfect owing to the brittle gibbsite crystals which line passages and cavities breaking away in the vicinity of the saw-cuts. Slices were cut thick and, after carefully removing dust from cavities, impregnated with Canada balsam. Half the thickness of the slice was ground away before mounting on the slip. Sections of laterite should be much larger than those usually prepared in the study of igneous rocks. They were examined first with low-power objectives, at least 1½ inch, then with higher powers. It is only rarely that magnification as high as 250 diameters is necessary. Single sections, especially if small, are apt to convey a totally false impression as to structure. When coarse-grained, non-homogeneous, or showing traces of the original structure of the mother rock several sections are necessary. Many quartzose laterites contain grains of quartz loose in cavities. Such grains are liable to drop out of the polished slice before attaching it to the glass slip and, unless observed and fixed in position, their existence may be entirely overlooked.

(b) Laboratory Work; (3) Experimental. —A considerable amount of work has been done on the dehydration of ferric hydrate, as well as on the composition of ferric hydrate precipitated under various conditions, which throws some light on the dehydration of ferric hydrate in laterite.

General Remarks. — Even with the assistance of every device known in chemical analysis and microscopic investigation we are not in a position to deal satisfactorily with all the problems laterite presents. The most serious difficulty arises through lack of material in a state of purity. Amorphous ferric and aluminium hydrates mix in all proportions with one another and with hydrous silicate of alumina as well as with titanium hydrates, not to mention those of manganese, chromium, &c. The study of the state of hydration and the determination of the minerals actually present is an extremely complex problem.

Chapter II.—The Decomposition of Crystalline Rocks near the Surface.

In every drainage area where rain falls the rain absorbed forms near the surface a system of water travelling slowly in the strata from the higher points toward the lower. This system does not, under ordinary circumstances, penetrate much below the level of the lowest drainage of the area. It is convenient to call this "vadose" water, a term introduced by Posepny and used by Dr. Maclaren.[7] In order to understand rock decomposition it is advisable to divide the ground vertically into zones with reference to the vadose water system. We may conveniently adopt the nomenclature for these zones proposed by Mr. W. F. Smeeth[8], with slight modifications of the limits of the middle zone:

The Zone of Non-Saturation includes all ground above the reach of vadose water.

The Zone of Intermittent Saturation includes ground from the highest point to which capillarity raises vadose water down to the lowest point to which atmospheric oxygen can penetrate vadose water at its lowest level.

The Zone of Permanent Saturation includes all ground pervaded by vadose water below the zone of intermittent saturation.

It has been said that the alteration of crystalline rocks in the tropics and sub-tropics differs essentially from the same process in temperate and cold climates. This belief has been based mainly upon inadequate data and knowledge of both hot and cold regions. Let us first consider the results produced in the zone of permanent saturation. In warm climates we usually find vadose water to be more highly charged with carbonic acid, alkaline carbonates, and organic matter, also higher in temperature than in cooler regions. The alteration of rocks is consequently more rapid, but the closest examination has failed to reveal any

---

[7] Dr. J. Malcolm Maclaren, "Gold," p. 9.

[8] "Notes on Underground Water Resources in Mysore," Bangalore, 1911, pp 9–25.

material difference in the results produced. Such differences as do occur are differences of degree and not of kind. For example, iron in the tropics appears to be leached to a greater extent than elsewhere, but examples in which iron has been thoroughly leached in England, and iron-free clays left, are not at all uncommon.

As regards agents present in vadose water which cause changes in rock, carbonic acid and alkaline carbonates are most important. Acids of organic origin are always present in the tropics where vegetation exists, but I am constrained to believe that many people are inclined to exaggerate the effects they produce. They exist in temperate and cold climates in great abundance in many localities. Their invariable presence in vadose water renders quite impossible the idea that nitric acid produced by atmospheric electric discharges could have any effect in laterization; humic acid reduces it to impotence very rapidly.

Since warm water dissolves less carbon dioxide than cold water it is argued that there must be less carbonic acid in tropical vadose water than in temperate. This is true only as far as the solution of atmospheric carbon dioxide by rain is concerned. Sink a shaft to water-level near a tropical stream and another in a similar situation, say, in England, cover them over for a few days, then test the air within with a lighted candle. In the tropics the candle will be extinguished, whereas in England it will not be. In this way it is readily proved that vadose water in the tropics contains much more carbonic acid than in cooler regions. Observation leads me to believe that a solution of alkaline carbonates in carbonated water increases in activity greatly with even a small rise in temperature; that in the tropics such a solution removes silica from combination as alkaline silicate with evolution of carbonic acid. Ferrous iron is liberated, forms carbonate, and goes into solution as ferrous bicarbonate. Lime and magnesia are removed in the same way. These reactions take place in the vadose region in all climates, the rapidity of action varying with the temperature. Double silicates break up readily, yielding ultimately hydrous silicates of magnesia and alumina. The former disappears in the tropics, leaving the latter only. Even quartz is slowly dissolved.

It appears that no ordinary double silicate can resist the prolonged action of alkaline carbonated water in any climate, and that the ultimate solid residue everywhere is mostly hydrated aluminium silicate. Certain double silicates yield serpentine as the result of partial leaching in the absence of oxygen. Serpentine is essentially a hydrous silicate of magnesia, in which part of the magnesia is replaced by ferrous oxide. This change can only take place in a reducing zone below water-level. Talc is another alteration product of minerals similar to those yielding serpentine, but talc is an acid silicate containing less iron than serpentine, and that little always in the ferrous state, so it also is produced below water-level. Even these intermediate changes in ferriferous minerals going on below water-level indicate that iron is gradually reduced to the ferrous state and partly eliminated. Ultimately it is entirely removed. Under vadose conditions the chemical union of silica with oxides of iron is weak, and that with alumina very strong. Iron leached from rocks below is found in abundance as ferric hydrate and oxide on the surface; free alumina is comparatively rare.

The decomposition of felspars below water-level results in hydrous silicate of alumina, either directly or with the intermediate production of sericite. Outlines of crystals of various double silicates of the mother rock may often be seen with the microscope in sections of completely kaolinized material derived from either acid or basic rocks. The word sericite is here used in the sense to which Laspeyres refers as its original meaning, namely, a micaceous product of the alteration of felspars. The mineral now called sericite is the result of alteration of orthoclase and corresponds approximately to muscovite in composition. The soda plagioclases yield a product physically resembling this very closely. For present purposes it is immaterial which alkali metal is present, the point being that alkali felspars are capable of alteration *in situ*, which results in the formation of crystalline hydrous double silicate as an intermediate stage in their conversion into "kaolin." The conditions which determine sericitization are unknown; in some cases it takes place, in others there is evidence that it does not.

The writer has sections of both dolerite and granite in which the felspars were sericitized previous to transformation into hydrous silicate of alumina. Fibrous structure develops, accompanied by swelling, which causes distortion of the outlines of the felspars. This is particularly noticeable in plagioclase laths. In such cases the augite and olivine crystal outlines have not suffered.

The frequent occurrence of distortion of the outlines of felspar crystals in laterite was very puzzling until examples of sericitization accompanied by similar distortion were encountered in the study of various semi-decomposed igneous rocks from different parts of Africa.

It is unfortunate that we have no word signifying the changes in rocks occurring below water-level in contra-distinction from those taking place above that level. Some use the words "alteration," "weathering," and "decomposition" as almost synonymous terms. I use the term "alteration" to cover rock changes taking place below water-level, and "weathering" to signify those taking place above that level. This is done for the sake of clearness, and because it is necessary to distinguish between the two forms of change in dealing with laterite, but with no desire to impose these restricted meanings on the scientific world. One cannot protest too strongly however against the word "weathering" being applied to rock changes going on below water-level in a zone of reduction where weathering usually must of necessity involve oxidation. What happens with an olivine crystal by alteration or by weathering illustrates the difference in decomposition taking place below and above water-level. Alteration eliminates iron, leaving hydrous silicate of magnesia, which also disappears in solution ultimately. Weathering first results in oxidation of the iron with separation of ferric hydrate, and the final result is frequently a cavity occupied by only ferric hydrate or oxide. Surely changes which may differ so radically should not go under the same name.

As soon as we pass upward from the zone of permanent saturation to that of intermittent saturation a new and important factor may be introduced, namely, atmospheric oxygen. When this is introduced the altered rock, light in colour owing to absence of iron, gives place to red or brown material containing ferric hydrate, but in the tropics we find in such places aluminium hydrate as well. Ferric and aluminium hydrates, however, are not always deposited in the zone of intermittent saturation in the tropics, in fact it is the exception rather than the rule to find them. Moreover their presence is not by any means confined to the tropics, for aluminium hydrate in the free condition has been proved[9] to be present in quite notable quantity in many soils in temperate climates. Objections have been raised against certain of the results referred to. Little or no importance can be attached to a reported excess of alumina amounting to one or two per cent, but so many of the analyses referred to show a large excess of uncombined alumina that it seems unreasonable not to admit that the existence of free alumina in surface deposits in temperate climates has been proved.

I am convinced that rock decomposition in Tropical Africa does not differ except in degree from the same process in temperate regions. Prof. Lacroix[10] has reached the same conclusion. Altered rock underlying laterite in course of formation resembles almost exactly the material yielded by similar rock and found in the zone of permanent saturation in Europe or the United States.

The amount of alteration which a rock undergoes in the zone of permanent saturation varies with the composition of the vadose water, its temperature, and the length of time the rock remains in that zone. The time element is the most important. The factors controlling time are crustal movements and the rate of denudation. In an area of regional depression when denudation is slow, the rock may pass down out of the zone of permanent saturation and cease to be leached, and at the same time sediments may collect on the surface. In an area of elevation rock may pass upward through the zone of permanent saturation so rapidly as to emerge above water-level practically unaltered.

The amount of alteration a rock undergoes varies inversely with the rate of denudation in the absence of crustal movements. Dr. Evans states[11] that in the zone of permanent saturation rock decomposition is at a minimum. This possibly may be true as regards the rate of decomposition, but it is open to serious question if we consider the total amount of rock decomposed. Many rocks which undergo complete decomposition in the zone of permanent saturation, if raised to the upper zones in an unaltered condition, do not undergo any but the most superficial change in the tropics. They remain in a condition of the most surprising freshness even though exposed to rain and other atmospheric influences for centuries. Prof. Lacroix[12] in dealing with nepheline syenite, gabbro, diabase, and peridotites makes special mention of the fresh condition of rock in almost immediate contact with laterized material containing practically none of the original mineral constituents. If a rock has not been rendered porous or permeable by rain water in the zone of permanent saturation, it will not in the tropics undergo material change in the zones above.

---

[9] *Econ. Geol.*, 1914, pp. 112–21.

[10] Op. Cit., pp. 346–7.

[11] Proc. Geol. Assoc. xxv., pt. 4, 1914, p. 243.

[12] Op. Cit., p. 271.

Rock weathering proceeds far more rapidly in cool than in warm climates. The disintegrating effect of frost on moist rock is the cause of this. Compare the rapid crumbling of the cliffs near Niagara Falls with the permanence of those on the Zambesi below Victoria Falls. Dr. Evans[13], in illustrating the difference between the results of rock decomposition in the tropics and in temperate climates, compares the residues from dolerites of the Western Ghats, Bombay Presidency, and Rowley Regis, near Dudley. The Indian example is laterite produced, first by alteration in the zone of permanent saturation, and then it must have been in the zone of intermittent saturation for a long period subjected to secondary change by which its original iron minerals were removed. Judging by the composition of the English representative it was produced largely if not entirely by weathering, that is, in the zone of non-saturation. It would not be difficult to show differences quite as startling in the composition of residues of dolerite in the tropics, one the result of alteration and the other laterization. It is not fair to compare rock decomposition in different countries solely on the basis of the nature of present residues. To be comparable we must satisfy ourselves that each rock suffered decomposition in a similar position with reference to vadose water-level.

Let any geologist estimate, in a laterite country, what percentage of surface area and of vertical depth of decomposed rock is at present undergoing laterization, and the smallness of the result will at once demonstrate the folly of the assertion, so often repeated, that the ultimate result of rock decomposition in the tropics is laterite. It is necessary to realize that only a very small percentage of the altered rock of any country ever reaches a position where its conversion into laterite is possible.

CHAPTER III.—PHYSICAL CONDITIONS OF THE OCCURRENCE OF LATERITE.

ANCIENT LATERITES AND BAUXITE.—The many points of resemblance between the ancient and recent lateritic rocks including bauxite compel me to the conclusion that their mode of origin is identical.

I must state my conviction that the hydrates of iron and aluminium when occurring as important constituents of rocks evidently formed on the surface are of lateritic origin, that is to say, that these hydrates are the result of a series of chemical changes brought about by means of carbonated alkaline water and oxygen. An important generalization by Laur [14] is as follows: "La présence des bauxites toujours coincide avec une lacune stratigraphique." The fact has been established that bauxites come into existence on land in positions where denudation proceeded for long periods undisturbed by volcanic action or by serious crustal movement. Bauxite beds are therefore surface formations, and consequently rocks overlying them have no bearing upon their mode of origin.

Let us now consider the nature of rocks underlying them. Of the Antrim beds, F. R. Mallet[15] says: "The lithomarge underlying the Antrim beds and that beneath the laterite (or perhaps I should say the first of the two forms described by Mr. Blanford in the Manual of the Geology of India, p.353) are so similar that I am unable to indicate any lithological distinction between them except that I have not observed any pipes in the Irish rock. Mr. Kinahan remarks that the bright coloured lithomarges (of Antrim) are identical in aspect with some of the varieties of steatitic laterites collected by Wynne in Kutch, India. Both are argillaceous, often pisolitic, forms of highly ferruginous rock; the iron in both is mainly in the state of hydrous and anhydrous ferric oxide. Both are associated over large areas with underlying lithomargic beds and both are intimately connected in some way with volcanic rocks." Parts of the bauxite beds of France, Austria, and Italy overlie calcareous rocks. Much of the French bauxite overlies gneiss, granite, Permian clay, and trachyte. In Auvergne it overlies gneiss[16]; in all cases the underlying rocks are decomposed. The Arkansas bauxite[17] overlies beds of kaolin 6 to 30 ft. thick, below which we find syenite. Each bed merges gradually into that lying below. At its edges it is interbedded in contemporaneous Tertiary rocks unconformable with the syenite. The southern Appalachian bauxites[18] overlie semi-crystalline silicious dolomite. The New South Wales bauxite[19] merges downward by insensible gradations into basalt.

One characteristic of all bauxites is that fossils never occur in them. It would serve no useful purpose to recapitulate the various theories of the origin of bauxite. These have

[13] Op. Cit., p. 238-9.

[14] "Les Bauxites dans le Monde," C.R. Soc. de l'Ind. Min., May and Nov.-Dec., 1908.
[15] Rec. Geol. Sur., India, Vol. 15, p. 145.
[16] Laur, Op. Cit.
[17] W. F. B. Berger, *Eng. & Min. Jour.*, Vol. 77, pp. 606-7, and W. F. Mead, *Econ. Geol.*, 1915, pp. 28-54
[18] C. Willard Hayes, Trans. Am. Inst. Min. Eng., Vol. 24, p.243.
[19] *Min. Jour.*, 3 June, 1899.

been enumerated and criticized by Laur.[20] One phenomenon of practically all bauxite beds has been the *bête noire* of all these theories, and that is the existence of a decomposed layer between them and unaltered underlying rock. Bauxite beds overlie lithomarge, bole, kaolin, or other products of the alteration of immediately underlying rock; they are non-fossiliferous; overlying rocks are unconformable with those underlying them. Over considerable areas they cover underlying rocks the varying nature of which does not materially affect their composition. Any theory of the origin of bauxite irreconcilable with these facts must be abandoned as false.

RECENT LATERITES. — Under this head are included all rocks of recent origin commonly regarded by geologists as lateritic, whatever may be their supposed origin and much that certain geologists call by such names as "surface ironstone."

(1) Mode of Occurrence:

(a) They exist as surface layers only, occurring either bare or covered by at most a few feet in thickness of soil.

(b) They occur on flat or gently sloping ground almost exclusively. Personally I have never seen laterite on a steep slope, and the only geologist who records such, to my knowledge, is Mr. F. P. Mennell[21] who saw it in Rhodesia overlying granite on comparatively steep slopes swampy in the rainy season. It is seldom one finds swampy ground on steep slopes, and I can quite realize that laterite could form on steep slopes under such unusual conditions.

(c) Laterite beds are very limited in thickness, rarely exceeding 30 ft., and are usually much thinner.

[20] Laur. Op. Cit.
[21] *Geol. Mag.*, 1909, p. 350.

(d) They never occur superimposed one vertically above another with unlaterized ground or rock between, nor do they form under water. It is unlikely that any geologist will cast doubt on the substantial truth of these four statements: they are of great importance.

2. Live and Dead Laterites.—A very definite line must be drawn in the field between live laterite or that in process of formation, and dead laterite or that in which laterization is no longer actively operative. The distinction is not usually recognized clearly or appreciated. A diagram will explain. To make it more readily understood the vertical scale is greatly exaggerated.

This is a diagrammatic transverse section across a stream bed of a type common in the tropics. The left bank is steep, composed of decomposed schist below and crowned with laterite. *S* is the stream. The right bank has a gradual slope leading to a steep one also capped with laterite *CcDd*. The maximum vadose water-level is at *AE* and the minimum at *ae*. The zone of laterization is *AabB*. It is in this zone and only in this that laterite is now forming. The laterite *CcdD* is dead because it is far above vadose water-level. The zone *cBEd*, including the steep slope, is composed of altered schist. Laterization cannot proceed there because it is above the reach of vadose water. In the area *BbeE* laterite is not forming because the thickness of rock above is too great to allow of oxygen reaching the vadose water; the same applies also to part of *cBEd*. The upper portion of the laterite at *AB* is detrital, the lower part laterized and partly laterized schist merging gradually into altered schist below the line *ab*. Laterization which is active from *Aa* to *Bb* rapidly ceases upon proceeding farther in the same direction under the steep slope. The mass of

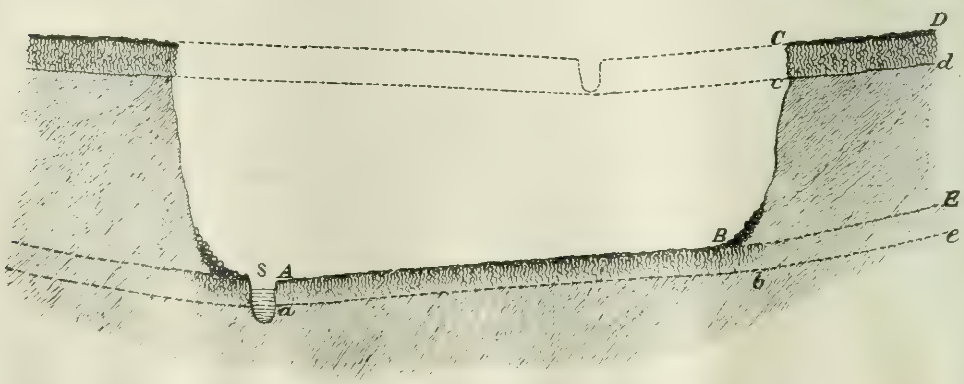


DIAGRAM SHOWING THE DIFFERENCE BETWEEN LIVE AND DEAD LATERITES.

this is soon of such a thickness that it prevents ready access of oxygen to the vadose water. The dead laterite capping the stream banks was practically a continuous sheet at the time of its formation. It was in fact the old stream bed and the water-channel lay at its lowest point (shown dotted in the diagram).

The sequence of events following this state of affairs explains the method by which successive terraces of laterite form. This terrace-like succession has been explained on the assumption that they are evidence of periods of alternating wet and dry conditions which promote and prevent the formation of laterite. The writer cannot find any justification for this assumption. Terrace formation is quite simply explained. It occurs on the slopes around mountains and also on river banks. Let us take the latter case. As laterite beds thicken their rate of formation diminishes rapidly, and in most cases when over 20 ft. thick the process has practically ceased. In other words laterite cannot go on increasing in thickness downward *pari passu* with the lowering of the vadose water-level caused by river erosion. Sooner or later the laterite on our stream banks is left above water-level and hydrates can no longer be deposited. Until this stage the stream would occupy only a narrow channel between laterite escarpments, the resistance of which prevents rapid widening. As soon as the stream reaches the soft altered schist below the laterite, widening becomes much more rapid owing to undermining, the laterite breaking away first on one bank and then on the other. Working its channel across the bed again and again, the bed is gradually widened. Until considerable width is attained it is impossible for laterization to have enough time (although constantly operative on any flat or gentle slope near the stream) to consolidate the ground sufficiently for it to offer effective resistance in preventing the stream from working its channel laterally across its bed. Probably erosion goes on for thousands of years and the greater part or in places even the whole of the upper laterite is removed before a lower layer has time to consolidate, but ultimately it must do so. This in its turn will be killed by river erosion, and by a continuance of the process terrace after terrace will form. If laterite could develop downward as rapidly as vadose water-level is lowered by denudation it would attain to hundreds of feet in thickness and terraces would not be formed.

Dr. Fermor[22] in his original description of lateritoid records the occurrence of this in isolated patches with a flat surface and at different levels. This possibly may be explained in a similar way, but developed on hill slopes instead of steam banks. Examples of this terrace arrangement of laterite beds and the occurrence of isolated patches at different levels are not uncommon in French Guinea, and also in other countries. They have no connection with alternating humid and arid conditions, but are the natural result of erosion on beds slow in forming, increasing downward at a diminishing rate for a limited distance and possessing extraordinary resistance to subaerial denudations.

(*3.*) *Rocks Underlying Laterite.*—The layer immediately underlying recent laterites is usually decomposed rock or sedimentary material bleached by the removal of its original iron contents and into which the laterite passes by insensible gradations. Lithomarge underlying so many Indian laterites is so well known as not to require further description. Dr. J. B. Evans[23] says that in boring for oil in Southern Nigeria, Tertiary beds were passed through, then crystalline rock. The zone of decomposition was shallow and the altered material pale in colour as if the iron had been reduced. Mr. E. A. Simpson[24] says: "Primary laterite in Western Australia when sunk through is found to overlie almost pure pipe-clay and this in turn crystalline rock." Mr. Arthur Holmes[25] says of Mozambique: "The general upward succession appears to be from unaltered gneiss through moist, disintegrated gneiss to similar material deeply stained with ferruginous cement." Professor Lacroix[26] describes gibbsitic laterite in the Isles de Los as overlying white clay which is derived from and rests on syenite. The same author[27] states many metres of bleached clay with quartz lie between the mica schist and laterite of Haute Guinée; he also says[28] that all granites he has seen undergoing laterization are kaolinized first.

The writer's own observations in many parts of Africa as well as in Western Australia prove that, with few exceptions, the rocks immediately underlying laterite are altered and leached of iron, often being quite white and consisting of hydrous silicate of alumina, with or without quartz, depending upon whether the underlying rock contained quartz or not. Even

[22] Mem. Geol. Surv., India, xxxvii., 1909, pp. 381–3.

[23] Proc. Geol. Assoc., xxv., 4, 1914, p. 237–8.

[24] *Geol. Mag.*, 1912, p. 399.

[25] *Geol. Mag.*, 1914, p. 531.

[26] Op. Cit., p. 281.

[27] Op. Cit., p. 306.

[28] Op. Cit., p. 316.

alluvial beds are bleached by the extraction of iron below the zone of laterization. In the Guianas similar conditions hold. A friend brought me many laterite samples from Surinam with full local descriptions. One series showed a well-developed quartzose laterite at the surface and the most careful examination gave no satisfactory evidence of origin. A sample of material from below water-level at the same place proved it to be detrital; this consisted of a mixture of pure white clay with water-worn quartz fragments.

It is evident, therefore, that the layer immediately underlying laterite usually consists largely of bleached hydrous silicate of alumina. Sometimes unaltered rock underlies laterite, the transition being abrupt; the reason of this will be explained later. Mr. F. P. Mennell[29] says: "Laterite to my personal knowledge occurs in Rhodesia on nearly every possible description of rock." Prof. Lacroix gives examples of laterite overlying a great variety of crystalline rocks from granite to peridotite as well as alluvials of all kinds. The writer's personal experience in Africa is similar; laterite overlies practically all kinds of rock and certainly covers some that contain very little iron, alumina, or titanium.

(4.) Climatic Conditions; (a) Temperature.—Laterite forms in tropical and sub-tropical countries, never in temperate or cold regions. Speaking generally this statement is true, for we do not find laterite beds in the higher latitudes. It has come to be admitted pretty generally that the presence of free aluminium hydrate in a rock is essential before it can be properly regarded as lateritic, but, since it has recently been proved that many soils and clays contain uncombined alumina the existence of which was hardly suspected previously, we may yet be compelled to admit that lateritic material may be produced in limited quantity even in cool climates.

I am inclined to believe that when local conditions are favourable the reactions resulting in the separation of free alumina which take place in the tropics may also be operative in temperate regions. I believe temperature to be the main factor. It is possible that, as in the zone of permanent saturation, the differences between reactions taking place in the zone of intermittent saturation in tropical and in temperate climates may be differences of degree and not of kind.

(4.) Climatic Conditions; (b) Rainfall.—Probably no one will be inclined to dispute the truth of the statement made by so many geologists that a marked alternation of wet and dry seasons is favourable to the formation of laterite. We have good reason for believing, however, that such an alternation is not essential, for we know that laterite is now forming in countries where rain falls during every month in the year. But even in the wettest of countries there is an annual periodicity of light and heavy rains.

We must realize that it is not the alternation of wet and dry seasons or of light and heavy rains *per se* that is the important factor in laterization; it is the effect of such alternation on the vadose water-level. During the wet season the vadose water-level commences to rise as soon as the amount of water absorbed by the soil and percolated down exceeds the amount draining away. The level frequently reaches the surface on flats and gentle slopes. During the dry season vadose water drains away and is evaporated; its level falls until rain comes and the amount absorbed by the soil equals the amount lost. The difference between maximum and minimum vadose water-level varies greatly in different parts of the same country. Its mean in any two countries will vary according to the difference in the amount of water absorbed by the ground in the wet and in the dry season.

Later it will be demonstrated that it is only in places where vadose water passes at or near the surface that laterization takes place; also that it is only practically between its high and low surface limits in the strata that laterite is forming at any given time.

It is evident for this reason that the study of the amount and nature of rainfall in its relation to the quantity absorbed by the soil in a laterite country is of great importance. Below will be found a table compiled from my own records in West Africa which will serve much better than figures appearing in meteorological records to show the true position as regards absorption of rain by the soil. Total rainfall is no criterion of the amount absorbed. For instance, gentle rain falling for say 6 hours and amounting to half an inch will practically all be absorbed, whereas the same amount falling within half an hour, as frequently occurs in tropical thunderstorms mostly runs off into the rivers. With reference to the percentage of total rainfall absorbed by the soil during heavy rains the Director of the Bulawayo Observatory says that in Rhodesia as much as 95% of heavy downpours flows off, and he does not consider that 10% is too low a figure to take as the amount absorbed by the soil during heavy

[29] *Geol. Mag.*, 1909, p. 350.

Records of the Intensity of Rain and Length of Dry Intervals at the Beginning of the Rainy Season in West Africa.

Country	Gold Coast				Ashanti				Haute Guinée				Haute Guinée				Northern Nigeria			
Year	1902				1904				1908				1909				1914			
	L	M	H	DI	L	M	H	DI	L	M	H	DI	L	M	H	DI	L	M	H	DI
January ...	1 31st	–	–	–	1 28th	–	–	– 35	–	–	–	–	–	–	–	–	–	–	–	–
February ...	4	3	2	9	–	-	–	–	–	–	–	–	–	–	–	–	–	1 28th	–	–
March ...	3	1	6	11	6	2	1	6	–	1 16th	–	32	2 27th	–	–	14	–	–	1	28
April	2	2	8	5,5	3	4	3	8	–	2	–	8	3	1	–	7	3	1	–	21
May	7	7	12	2	2	3	7	6	6	4	2	6	1	2	3	9,7	4	2	1	6,6
June	Very Wet				Very Wet				2	3	3	6	3	4	4	5	2	3	4	5,5

rains throughout Rhodesia. The result is that of the total rainfall he computes that 23% flows off. In many countries near the equator we find a predominance of heavy downpours over moderate and light rains much greater than occurs in any part of Rhodesia, so that a very much greater proportion than 23% runs off in wetter countries, the percentage rising very rapidly when the ground is nearly or quite saturated.

In the table I divide rain into three types: light (L), that which is practically entirely absorbed by the soil; moderate (M), that which is largely absorbed; heavy (H), that which mostly flows off, and causes floods in the rivers. The date on which the first rain of the season fell is given in each case in brackets. Dry intervals (D.I.) are given for each month, the numbers indicating the period of days in succession on which no rain fell. Records in the table are discontinued at the time when the ground approaches saturation.

Heavy floods in the rivers always occur in Tropical Africa before the ground has approached saturation. Light to moderate showers usually prevail at the beginning of the rainy season. This is very important, because the alkaline carbonates and organic acids derived from the decomposition or burning of the previous season's vegetation then pass into the soil and down to the vadose water almost wholly, whereas, if heavy rain fell first, they would be washed away to such an extent that their leaching effect would be almost entirely lost.

From the date on which the first shower of the season falls in Tropical Africa until the regular flowing of the very small streams commences, an interval of at least two to three months elapses. Saturation of the soil or the attainment of maximum vadose water-level is indicated by the overflow of vadose water from the soil into the very smallest streams and water-courses, causing them to flow, and this flow continues until the rains slacken considerably. Prof. Lacroix was misinformed on this matter or he would not have stated that saturation of the ground is reached in a few weeks after the first rain falls. Dr. Fermor's remarks[30] on this matter are decidedly apropos.

Alkaline carbonates and organic acids are dissolved by the early showers and, as relatively strong solutions, permeate the soil and leach it for weeks before their strength is reduced by dilution. This probably has some bearing on the rapidity of laterization that marks the region just north and south of the great African equatorial forest belt.

The records for the Gold Coast and Ashanti prove that even in the forest belt the rains come on slowly. The similarity of the rainfall in French Guinea and Northern Nigeria is very noticeable. In both places laterization is proceeding actively in suitable situations.

In any tropical country a material variation in the level of vadose water between the seasons of maximum and minimum rain must result in the formation of laterite. There is reason to believe that the greater the variation the more rapidly laterite forms. It is hard to believe that any wet tropical country has a rainfall so uniform that the vadose water-level never varies and as hard to realize what such a state of affairs would bring about, but any condition short of that would in my opinion permit laterite to form.

[30] *Geol. Mag.*, 1915, p. 129.

(To be continued).

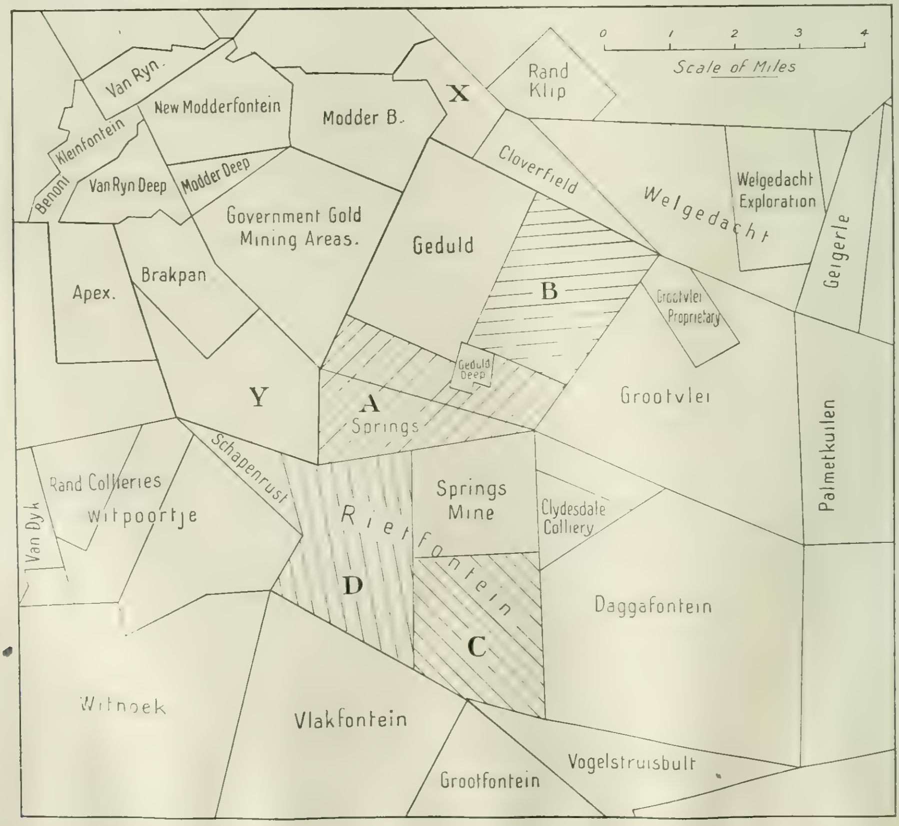
SPECIAL CORRESPONDENCE

JOHANNESBURG.

New Far East Rand Leases.—The advertisement inviting tenders for the exclusive right to mine for precious metals on four new areas on the Far East Rand has just appeared. There can be little doubt, seeing that these four new areas are the pick of what is left in the best proved portion of the Far East Rand, that the competition will be keen, and already the Springs Mines and the Geduld Proprietary Mines have taken the preliminary steps toward taking part in the competition. Perhaps the most promising area for which tenders are now asked is that marked (*A*), consisting of the farm Springs with a portion of the farm Geduld, having a total area of 2,050 claims, for which it is officially estimated £800,000 will be required for shaft-sinking and preliminary development and another £700,000 for equipment to bring the property to the producing stage. The depth to the reef on this area varies from 3,000 to 4,000 ft., the bulk of the ground carrying the reef at a depth of about 3,500 ft. It may be interesting to note that the Springs Mines spent one and a half million sterling before reaching the producing stage. It is quite possible that there will be water difficulties to contend against in the shaft-sinking, but the Karroo and dolomite beds may have become drained to some extent by the pumping at the Springs Mines. Perhaps in the dolomite beds the use of cementation may be found necessary, seeing that in the Yorkshire coalfield, near Doncaster, in similar beds that process was quite a success.

With regard to the Geduld East area marked (*B*), this comprises the largest individual area now offered for lease and consists of 2,526 claims, with the reef at an average depth of 3,000 ft. from the surface. To all intents and purposes it forms a deep-level area to the mynpacht of the Geduld, which has also an area of 2,481 claims with the reef running say at a depth of from 1,500 to 2,500 ft. For this proposed new leasehold area it is estimated that £900,000 will be required for shaft-sinking and development, and another £800,000 for equipment. This area carries the reef at a much less depth than any of the other areas for which tenders are now being asked. Lying as it does between the Geduld and Grootvlei shafts, water troubles in connection with the sinking may be anticipated. At Grootvlei sinking operations were suspended on account of the heavy feeders of water encountered in the soft coal-measure sandstones and dolomite beds, and recourse may also be necessary here to the cementation process especially in the dolomite formation.

The other two areas offered for lease constitute the balance of the farm De Rietfontein No. 14 belonging to the Transvaal Coal Trust after the Springs mynpacht and discoverer's claims have been deducted. This balance is divided into two equal portions of 2,236 claims each, marked (*C*) and (*D*). The De Rietfontein East area consists of the southern deep level of the Springs mynpacht, bounded on the east by Daggafontein, and on the south by Vlakfontein and Vogelstruisbult. The reef in this area must lie at a depth



The Far East Rand.

of over 5,000 ft. from the surface, and taking every indication into consideration, the area ought to prove profitable. If worked as an individual property, it is estimated that £900,000 will be required for shaft-sinking and preliminary development, and an additional £800,000 for equipment.

De Rietfontein West area is bounded on the north by the Springs farm, and a small portion of Brakpan, while on the west is Schapenrust and Witpoort. On the south lies Vlakfontein No. 26, and to the east the Springs mynpacht and De Rietfontein East area. The depth to the reef on this area will vary from 4,000 to 5,000 ft. from the surface. The capital requirements are estimated by the Government to be the same as for the De Rietfontein East area. The conditions of lease are in all respects similar to those for the Brakpan South and Modderfontein East areas.

As before remarked the areas now offered for lease constitute the pick of the Far East Rand, and probably the only one of doubtful value is the De Rietfontein West Area, marked *(D)*. It will be remembered that in the north-west corner of Vlakfontein No. 26, the Lace Proprietary Mines put down a bore-hole, and in a deflection at a depth of over 4,800 ft. from the surface, the Main Reef body was thick, the leader assaying 13 dwt. over a width of 13 inches, and the upper half of the Main Reef 5 dwt. over 35 inches. The farm Witpoort lying to the west of De Rietfontein has not a good reputation, the results obtained at Van Dyk and Rand Collieries situated on this farm being anything but encouraging. It will also be remembered that a bore-hole on the eastern portion of Witpoort was put down in 1911, to the depth of 5,500 ft., and the option which the prospecting operations carried was not exercised. On this account the operations on De Rietfontein West will be watched with interest.

There ought to be some interesting competition for these areas, for which the Consolidated Mines Selection occupies the best position, especially as regards the areas marked *(A)*, *(C)*, and *(D)*, while the Geduld is expected to make the best bid for *(B)*. It is equally certain that there will be other tenders, but there seems little prospect of the Grootvlei Proprietary Mines or the Lace Proprietary Mines proving themselves dangerous competitors, although they hold properties in the immediate neighbourhood capable of being worked to advantage in connection with several of these areas for which tenders are now invited.

[In the map, *X* refers to the area taken by the Central Mining Corporation and amalgamated with Rand Klip and Cloverfield to form Modder East Limited. *Y* is South Brakpan, which with Schapenrust was acquired by Brakpan. The *X* and *Y* areas were offered by the Government in October last.—EDITOR].

TORONTO.

THE LABOUR SITUATION.—Labour conditions in the mining districts of Northern Ontario have for some time been considerably unsettled on account of a long-standing dispute over wages. Owing to the high cost of living, the miners demanded an all-round increase amounting to about 50c. per day. In many cases temporary compromises were made by the granting of special bonuses in addition to the regular pay; but this system was not satisfactory to the men, who insisted on a permanent increase. The principal difficulty in the way of a settlement was the unwillingness of the mine managers to recognize the Union, on account of its being affiliated with the Western Federation of Miners. They refused to negotiate with the union leaders, and at one time a general strike appeared inevitable. This danger has been fortunately averted by the policy adopted by the mine managers of Porcupine. While maintaining their position as regards non-recognition of the Union, they agreed to meet representatives of their own men only, and consider their demands. As a result several of the leading companies consented to grant the increase asked for, the increased rate to continue so long as the cost of living remained higher than it was in August 1914, all bonuses being discontinued. The situation in Cobalt differed somewhat from that in Porcupine, as the miners had been for some time receiving bonuses based on the continuance of the high price of silver, nearly or quite equal to the increase in wages asked for. This system was objected to on the ground of its uncertainty, and the men voted to strike unless they obtained a permanent increase of 50c. to the basic wage. Following the example set by the Porcupine mine owners, conferences between the officials and committees representing the miners were held, and the men were assured that the bonuses would be continued even if a drop in silver occurred, so long as the cost of living remained higher than before the war. The men waived the question of recognition of the Union, and are apparently satisfied to remain at work.

PORCUPINE.—The shortage of efficient labour has latterly considerably curtailed production, though the situation shows improvement since the settlement of the wage dispute, and some mine-workers are coming in from other places. The gross profits of the Hollinger Consolidated during the 4-weekly period ended May 20 were \$92,809, as compared with \$194,688 during the previous four weeks. The mill, which only ran 65% of possible running time, treated 35,337 tons of ore, of the average value of \$7·49 per ton, as against 42,849 tons of the value of \$9·20, and the working costs were \$4·66 per ton. Good progress is being made with the new equipment. The central shaft has been put in operation, and is now exclusively used for the hoisting of ore. All ore-bodies opened up are to be made readily accessible to this shaft, which will reduce operating costs. Among recent favourable developments is the cutting of a new vein on the 425 ft. level, showing a high average gold content. At the Dome Mines attention is being devoted mainly to the opening up of what is supposed to be the largest and most valuable ore-body in the mine as indicated by diamond-drilling. This lode is approximately 120 ft. wide and is estimated to carry \$17 to the ton. It is expected that ore from the lode will be available for milling early in August. The exploration of the Dome Extension is being systematically conducted by diamond-drilling from the 600 ft. level. An inclined hole is to be driven to a depth of 1 600 ft. It is regarded as probable that the Dome will exercise its option on the property. The McIntyre has greatly improved its position latterly. Diamond-drilling from the 1,000 ft. level has proved the existence of a vein 22 ft. wide carrying ore yielding \$20 to the ton at a depth of 1,325 ft. New equipment is being installed preparatory to sinking to this level. The drift at the 1,000 ft. level has passed into Jupiter ground, the ore-body maintaining its high grade and showing increased width. The Schumacher has temporarily closed down owing to labour shortage, but is preparing shortly to resume operations, and the construction of an addition to the mill which will increase its capacity to 280 tons per day is going forward. An important find has been made at the Davidson where a high-grade ore-body 32 ft. wide has been discovered by diamond-drilling. The West Dome Consolidated has a blocked-out ore reserve estimated at 70,000 tons, of the average value of \$9 per ton.

KIRKLAND LAKE. — This district has steadily increased in importance since a supply of power became available. The Teck Hughes during May produced bullion to the value of $9,712 from 1,295 tons of ore. The Lake Shore is preparing to install an 80 ton mill. A new vein found at the 200 ft. level has been opened up. For over 100 ft. it averages $40 per ton over a width of 4 ft., in addition to wall-rock forming good milling ore. The Wright-Hargraves has sunk No. 2 shaft to the 200 ft. level with encouraging results, and will sink 100 ft. deeper. At the Minaker-Kirkland a vein found some weeks ago is being developed in depth and is widening as the shaft goes down. The Tough-Oakes is as yet the only dividend-paying mine in the district and has up to date paid its shareholders $391,125.

COBALT.—The silver-mining industry has been less handicapped by labour shortage than gold-mining, and production is being stimulated by the high price of silver. The La Rose Consolidated has commenced the development of the Violet property, where a shaft will be sunk to the 300 ft. level. The Violet adjoins the O'Brien mine, and it is thought that continuations of veins in that property may be found. The Nipissing has increased its production as compared with last year. Official figures give the value of its output for the first five months of the year as $1,223,213, as compared with $970,995 for the corresponding period of 1916. A vein has been discovered on the Little Nipissing property, now operated by the Mining Corporation of Canada, at the depth of 250 ft. It is 4 in. wide and stated to carry 1,000 oz. to the ton. The old Green-Meehan mine is being re-opened and several hundred tons of ore on the dump will be treated. The Hargrave has made several good discoveries and one shipment of 12 tons brought returns of about $25,000.

BRITISH AMERICA NICKEL.—The construction of the new smelter and refinery of this company has been begun at a point about 4½ miles north-west of Sudbury. Plans were at first prepared for a plant to cost $7,000,000, but owing to important new discoveries at the Murray mine, the size will be considerably increased. The ore reserves are estimated at 3,000,000 tons at the Murray mine, and 5,000,000 tons at the other properties, in addition to which diamond-drilling has discovered extensive ore-bodies at the 950 ft. level believed to contain some 5,000,000 tons. The Hybinette process of electric refining will be employed, the company having purchased the rights for Canada and the United States. The company is capitalized at $20,000,000, of which the British Government controls $14,000,000. The whole of the output will go to the Government.

PERSONAL.

A. E. BIDLAKE, of the Prestea Block A, is on holiday in England.

W. M. BREWER has been appointed Resident Engineer for the Western Mineral Survey District, British Columbia.

M. A. BRUCE is home from Nigeria.

J. M. CAIRNS has received a commission in the General Reserve and is in charge of transport movements.

G. W. CAMPION is home from Taquah, West Africa.

ALEX. COLLEDGE is home from the Federated Malay States, and has received a commission in the Royal Flying Corps.

A. HARPER CURTIS has moved his office from Palace Chambers, Westminster, to 70 Terminus Chambers, Holborn Viaduct, London, E.C.1.

Z. W. DAW is home from Burma.

W. R. DEGENHART has returned to the Bawdwin mines, Burma, from the United States.

GEORGE A. DENNY has gone to Australia from South Africa.

LIEUTENANT-COLONEL A. WINTER EVANS, New Zealand Rifle Brigade, general manager of the Consolidated Goldfields of New Zealand group, and E.M. of Columbia, has been awarded the D.S.O.

G. G. HEWITT and C. O. WRAITH, underground manager and surveyor respectively of the Leeuwpoort tin mine in the Transvaal, have arrived in England to "join up." Mr. Hewitt went through the South-West African campaign, and Mr. Wraith served in East Africa.

AUSTIN W. HOY, recently European manager for the Sullivan Machinery Co., has received a commission in the Artillery.

E. B. LICHTENBERG has changed his name to ERNEST B. LIGHTHILL. As a British subject, born of British parents, and having no German relations or connections, his motive will not be misunderstood. He has recently been elected president of the Mining and Metallurgical Club.

ROBERT PILL has returned from South Africa to England, after having been in the service of the General Mining and Finance Corporation for twenty years.

LIEUTENANT-COLONEL S. H. POLLEN has been elected a director of the Central Mining & Investment Corporation.

LORD SALVESEN, chairman of the Arizona Copper Company, is resigning his position and will cease to be a member of the board at the end of the company's year, in deference to views expressed in some quarters that a Judge of the Scottish Courts should not also be a director of a commercial company.

WILTON SHELLSHEAR, lately of the Junction North mine at Broken Hill, is now with the Burma Corporation as manager of the concentration department.

SYDNEY A. R. SKERTCHLY is leaving on August 15 for Peru.

G. HILDICK SMITH, manager of the Bantjes mine, has been elected president of the Chemical, Metallurgical and Mining Society of South Africa.

E. GIBBON SPILSBURY, of New York, has been visiting mines in Cuba.

ROBERT C. STICHT, general manager of the Mount Lyell mine, is in America.

RALPH STOKES has been made Lieutenant-Colonel and is now Controller of Mines, First Army, British Expeditionary Forces.

MAJOR J. W. TEALE, D.S.O., is now in charge of a German prisoners' camp in the West of England, the prisoners being employed in forestry operations.

D A. THOMPSON, of the Abosso mine, left on July 11 on his return to West Africa.

H. W. TURNER was recently appointed manager for the American Oroville Dredging company.

J. B. TYRRELL has been appointed Canadian representative of the Consolidated Mines Selection Co. He continues also to represent the Anglo-French Exploration Company.

E. J. WAY has been elected a member of the council of the Institution of Civil Engineers as its South African representative.

S. S. WEBB-BOWEN is here from Nigeria.

WE regret to record the death of R. B. NICOLSON, for many years the manager of the Ivanhoe mine at Kalgoorlie.

METAL MARKETS

COPPER.—The official price of standard copper was reduced during the month from £130–£130. 10s. for cash to £125–£125. 10s. In America hesitation has been shown on the part of consumers to make purchases, and this hesitation is the outcome of the policy of the Washington authorities to control prices of all raw materials. Early in July some important sales were reported at 25 cents, a material reduction from the ruling quotation of 29-33 cents, and subsequently the quotation was reduced to 26½–27 cents. Producers and consumers alike appear to be now awaiting the decision of the authorities in regard to fixing a fair selling price, and it is likely that trading will remain light until this has been arrived at. As the refiners have enjoyed a long period of prosperity they are expected to raise no serious objections to a material reduction in their prices, nor is a reduction expected to have any effect on the volume of output, a consideration that will have great weight when almost unlimited supplies are essential to the successful prosecution of the war. The settlement of this important question would remove a weight from the market. Strikes have broken out in Arizona, but it is believed that stocks held of rough copper are sufficient to prevent any likelihood of a shortage in supplies.

Average prices of cash standard copper: July 1917, £128. 13s. 2d.; June 1917, £130. 5s.; July 1916, £95.

TIN.—Prices have been irregular, and the demand light. Cash tin was sold down to £237–£238, but the close of the month was better at £245–£246. On account of several vessels discharging in Liverpool instead of London a scarcity of London tin has been felt. In addition prompt supplies have been scarce, resulting in the establishment of a heavy backwardation amounting at times to £5. 10s. Batavia has shown great independence, holding for much over London prices. This is felt to be largely due to American trading direct with Dutch exporters. The same tendency is apparent in the Straits, where however the action of the British export control prevents an undue diversion of supplies from the English market. Trade in this country is slack, and it is reported that only about 30% of the tinplate mills are in operation. English tin is only in fair demand.

Average prices of cash standard tin: July 1917, £242. 6s. 5d.; June 1917, £242. 7s. 7d.; July 1916, £168. 9s. 6d.

LEAD.—There is no change in the official price of £30. 10s.–£29. 10s. Supplies in this country, however, are practically unprocurable for any other than national purposes, and Government control is being exercised more severely than ever. Shipments are still held up in Spain through want of shipping tonnage.

Average prices of soft foreign lead: July 1917, £30; June 1917, £30; July 1916, £27. 8s. 11d.

SPELTER.—Official prices remain at £54–£50. Business is rather irregular. The British policy of control is little understood. It is no doubt intended to favour lower prices, and to attract supplies, but it is doubtful if those in charge of the regulations are taking the best means to bring this about. American prices were somewhat easy during the month, but firmed up a bit later on.

Average prices of good ordinary brands: July 1917, £52; June 1917, £52; July 1916, £48. 7s. 6d.

The Australian Zinc Producers' Association quotes zinc dust at £85 to £98. 15s. per ton according to quality.

SILVER.—The price advanced to 41d. per oz. about the middle of July, but, on the Indian Government announcing that it had decided to exercise control of imports of silver into the country the position weakened. The price has again advanced, and at the time of writing (August 11) the quotation is $42\frac{1}{16}$d. per oz.

NICKEL.—£225 per ton. COBALT.—11s. per lb.

BISMUTH.—11s. per lb. CADMIUM.—7s. 6d. per lb.

CHROMIUM.—No quotation published for chrome ores; ferro-chrome £70 to £105 per ton.

TUNGSTEN.—Wolfram and scheelite, basis 70% WO_3, 55s. per unit. Ferro-tungsten 5s. 6d. per lb; tungsten powder 6s. 3d. per lb.

MOLYBDENUM.—Molybdenite, basis 90% MoS_2, 105s. per unit. Ferro-molybdenum 16s. per lb.

PLATINUM.—New 290s. per oz.; scrap 260s. per oz.

PRICES OF CHEMICALS. August 8.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d.
Alum	per ton	15	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	32	0	0
,, Chloride of, grey	per cwt.	1	18	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	70	0	0
,, Phosphate of	,,	95	0	0
,, Sulphate of	,,	15	10	0
Arsenic, White	,,	110	0	0
Bleaching Powder, 35% Cl.	,,	20	0	0
Borax	,,	37	0	0
Copper, Sulphate of	,,	63	0	0
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		11	4
Iron, Sulphate of	per ton	5	0	0
Lead, Acetate of, white	,,	95	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	46	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	11	0	0
Phosphoric Acid	per lb.			10
Potassium Carbonate	per ton	115	0	0
,, Chlorate	per lb.		2	6
,, Chloride 80%	per ton	60	0	0
,, Hydrate, (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	75	0	0
,, Permanganate	per lb		15	0
,, Prussiate, Yellow	,,		3	6
,, Sulphate, 90%	per ton	65	0	0
Sodium Metal	per lb		1	9
,, Acetate	per ton	85	0	0
,, Bicarbonate	,,	7	5	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	15	0
,, Hydrate, 76%	,,	26	0	0
,, Hyposulphite	,,	18	10	0
,, Nitrate, 95%	,,	24	10	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	7	0	0
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	24	0	0
Sulphur, Roll	,,	21	0	0
,, Flowers	,,	23	0	0
Sulphuric Acid, non-arsenical 144°T.	,,	4	5	0
,, non-arsenical 95%	,,	7	0	0
Superphosphate of Lime, 18%	,,	5	10	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
July, 1916	733,485	27,602	761,487	3,232,891
August	752,940	28,210	781,150	3,318,116
September	744,881	26,686	771,567	3,277,408
October	764,489	27,850	792,339	3,365,642
November	756,370	26,696	783,066	3,326,253
December	748,491	25,971	774,462	3,289,705
Year 1916	8,971,359	324,179	9,295,538	39,484,934
January 1917	756,997	25,637	782,634	3,324,418
February	696,955	24,366	721,321	3,063,976
March	760,598	26,496	787,094	3,343,363
April	717,598	25,180	742,778	3,155,121
May	753,531	26,034	779,385	3,310,618
June	732,799	26,925	759,724	3,227,101
July	731,848	25,991	757,839	3,219,094

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1916	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500
October 31	199,330	10,907	6,358	216,595
November 30	196,132	11,118	5,928	213,178
December 31	191,547	11,487	5,194	208,228
January 31, 1917	188,624	11,611	5,591	205,826
February 28	191,095	11,568	6,268	208,931
March 31	190,028	11,494	6,620	208,142
April 30	185,975	11,435	6,314	203,724
May 31	180,168	11,432	5,805	197,405
June 30	175,727	11,258	5,369	192,354
July 31	171,653	11,381	5,223	188,257

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
July 1916	2,370,244	26 1	17 10	8 0	949,606
August	2,423,669	26 3	17 10	8 1	976,125
September	2,367,793	26 6	18 0	8 3	972,704
October	2,453,437	26 4	17 10	8 2	1,001,843
November	2,389,056	26 9	18 2	8 2	980,387
December	2,349,191	26 10	18 2	8 4	977,481
January 1917	2,337,066	26 10	18 8	7 11	941,520
February	2,153,691	27 3	19 2	7 10	841,259
March	2,430,590	26 7	19 0	7 4	879,351
April	2,235,833	27 2	19 2	7 8	857,710
May	2,405,855	26 4	18 7	7 5	887,527

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1916	1917	1916	1917
	£	£	£	£
January	318,586	296,113	140,579	131,665
February	313,769	289,734	137,739	104,892
March	335,368	300,183	150,987	158,727
April	339,386	297,977	135,976	123,825
May	323,783	299,271	132,976	121,104
June	333,070	302,195	127,107	114,489
July	322,365	...	128,574	...
August	338,001	...	125,143	...
September	322,035	...	127,138	...
October	325,608	...	132,577	...
November	317,135	...	130,101	...
December	306,205	...	146,409	...
Total	3,895,311	1,784,473	1,615,306	754,702

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
July, 1916	912	91,725	92,637	393,495
August	*	89,522	*	*
September	*	85,978	*	*
October	*	82,732	*	*
November	*	87,322	*	*
December	*	88,205	*	*
January 1917	*	83,962	*	*
February	*	81,810	*	*
March	*	76,171	*	*
April	*	82,144	*	*
May	*	78,165	*	*
June	*	82,600	*	*
July	*	81,166	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1916	1917	1916	1917	1916	1917
	£	£	£	£	£	£
January	89,900	67,627	66,700	50,150	39,000	29,000
February	76,500	65,450	79,050	63,200	30,000	26,000
March	103,600	74,794	76,920	61,200	36,000	41,000
April	60,000	...	83,300	62,470	63,000	21,000
May	119,500	...	116,230	65,450	19,000	...
June	86,000	...	72,200	73,100	18,000	...
July	100,600	...	85,400	...	23,000	...
August	66,800	...	86,000	...	24,000	...
September	115,100	...	65,450	...	32,000	...
October	81,400	...	74,800	...	32,000	...
November	94,000	...	60,300	...	31,000	...
December	96,600	...	73,550	...	111,000	...
Total	1,090,000	207,790	940,500	375,520	459,000	116,000

Production of Gold in India.

	1914	1915	1916	1917
	£	£	£	£
January	193,140	201,255	192,150	190,047
February	185,508	195,970	183,264	180,904
March	191,853	194,350	186,475	189,618
April	189,197	196,747	192,208	185,835
May	193,031	199,786	193,604	184,874
June	192,224	197,447	192,469	182,426
July	195,137	197,056	191,404	179,660
August	196,560	197,984	192,784	...
September	195,843	195,952	192,330	...
October	198,191	195,531	191,502	...
November	197,699	192,714	192,298	...
December	211,911	204,590	205,164	...
Total	2,340,259	2,366,457	2,299,568	1,293,364

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper Standard	Copper Electrolytic	Copper Best Select'd	Soft For'n Lead	Zinc	Tin Standard	Silver
July	£	£	£	£ s.	£ s.	£ s. d.	d.
9	130	142	140	30 10	54 0	246 0 0	$39\frac{15}{16}$
10	130	142	140	30 10	54 0	246 10 0	$40\frac{5}{16}$
11	130	142	140	30 10	54 0	245 0 0	$40\frac{5}{8}$
12	130	142	140	30 10	54 0	243 10 0	$40\frac{3}{4}$
13	130	142	140	30 10	54 0	237 0 0	41
16	130	142	140	30 10	54 0	237 10 0	$41\frac{1}{4}$
17	130	142	140	30 10	54 0	239 0 0	$40\frac{15}{16}$
18	130	142	140	30 10	54 0	239 0 0	$40\frac{3}{4}$
19	130	142	140	30 10	54 0	239 0 0	$40\frac{3}{8}$
20	130	142	140	30 10	54 0	240 0 0	$39\frac{15}{16}$
23	125	137	135	30 10	54 0	238 15 0	$39\frac{7}{8}$
24	125	137	135	30 10	54 0	238 10 0	$39\frac{3}{4}$
25	125	137	135	30 10	54 0	239 5 0	$39\frac{3}{4}$
26	125	137	135	30 10	54 0	241 10 0	$39\frac{3}{4}$
27	125	137	135	30 10	54 0	243 5 0	$39\frac{5}{8}$
30	125	137	135	30 10	54 0	246 0 0	$39\frac{5}{8}$
31	125	137	135	30 10	54 0	247 0 0	$39\frac{7}{8}$
Aug.							
1	125	137	135	30 10	54 0	247 10 0	$40\frac{1}{8}$
2	125	137	135	30 10	54 0	247 0 0	$40\frac{5}{8}$
3	125	137	135	30 10	54 0	245 10 0	41
7	125	137	135	30 10	54 0	245 15 0	$41\frac{1}{2}$
8	125	137	135	30 10	54 0	247 0 0	$41\frac{7}{8}$
9	125	137	135	30 10	54 0	247 0 0	$42\frac{1}{16}$
10	125	137	135	30 10	54 0	244 10 0	$42\frac{1}{16}$

Imports of Ores and Metals into United Kingdom.

These figures do not include Government imports.

* Statistics not published. Long tons.

	Year 1916	May 1917	June 1917	Year 1917
	Tons	Tons	Tons	Tons
Iron Ore	6,905,936	*	*	*
Copper Ore	34,492	*	*	*
,, Matte and Precipitate	43,839	1,096	1,599	12,003
,, Metal	111,412	6,545	5,447	43,907
Copper and Iron Pyrite	951,206	*	*	*
Tin Concentrate	33,912	*	*	*
,, Metal	33,646	2,181	1,872	14,719
Manganese Ore	439,509	*	*	*
Lead, Pig and Sheet	157,985	6,828	12,204	62,919
Zinc (spelter)	53,324	3,314	2,519	26,437
	lb.	lb.	lb.	lb.
Quicksilver	2,556,214	4,568	—	77,016

Exports of Copper from United States

Reported every month by the United States Customs.

1916	Long tons	1916	Long tons	1917	Long tons
January	21,863	July	35,048	January	25,540
February	20,548	August	34,700	February	21,937
March	24,006	September	28,572	March	51,246
April	19,980	October	32,712	April	79,001
May	14,700	November	21,433	May	45,241
June	38,277	December	21,438	June	—
		Total 1916	313,277	Total 1917	225,967

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1916 Tons	May 1917 Tons	June 1917 Tons	Year 1917 to date
Bisichi (Nigeria)	473	15	15	157
Briseis (Tasmania)	467	26	27	180
Dolcoath (Cornwall)	1,076	76	110	446
East Pool (Cornwall)*	1,012	90	80	529
Gopeng (F.M.S.)	1,113	91	91	510
Malayan Tin (F.M.S.)	1,104	64	77	377
Mongu (Nigeria)	576	36	35	293
Naraguta (Nigeria)	523	31	38	233
N. N. Bauchi (Nigeria)	578	45	45	260
Pahang (F.M.S.)	2,591	220	220	1,300
Rayfield (Nigeria)	658	50	50	300
Renong (Siam)	894	85	98	476
Siamese Tin (Siam)	906	68	69	434
South Crofty (Cornwall)*	700	59	60	343
Tekka-Taiping (F.M.S.)	651	35	35	207
Tongkah Harbour (Siam)	1,135	101	87	649
Tronoh (F.M.S.)	1,662	94	93	529

* Including Wolfram.

Stocks of Tin.

Reported by A. Strauss & Co. Long tons.

	May 31, 1917	June 30, 1917	July 31 1917
	Tons	Tons	Tons
Straits and Australian, Spot	2,149	2,595	2,488
Ditto, Landing and in Transit	1,255	50	900
Other Standard, Spot and Landing	359	293	744
Straits, Afloat	5,617	5,000	4,093
Australian, Afloat	85	85	30
Banca, on Warrants	—	—	—
Ditto, Afloat	1,541	2,567	1,817
Billiton, Spot	—	—	—
Ditto, Afloat	100	233	290
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,455	1,530	1,410
Afloat for United States	3,339	4,095	5,145
Stock in America	4,402	2,332	1,722
Total Stock	20,302	18,780	18,639

Shipments and Imports of Tin

Reported by A. Strauss & Co. Long tons.

	Year 1916	July 1917	Total 1917
	Tons	Tons	Tons
Shipments from:			
Straits to U.K.	27,157	1,465	16,304
Straits to America	25,943	2,700	14,052
Straits to Continent	8,487	245	6,240
Australia to U.K.	2,537	—	349
U.K., Holland, and Continent to America	14,863	675	8,335
Imports of Bolivian Tin into Europe	15,116	569	9,560
Deliveries in U.K.	16,862	1,118	7,657
" ,, Holland	943	67	421

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1912	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531	665
February	240	427	469	358	528	645
March	247	510	502	418	547	653
April	141	430	482	444	486	554
May	144	360	480	357	536	491
June	121	321	460	373	510	445
July	140	357	432	455	506	...
August	201	406	228	438	498	...
September	196	422	289	442	535	...
October	256	480	272	511	584	...
November	340	446	283	467	679	...
December	310	478	326	533	654	...
Total	2,540	5,103	4,708	5,213	6,594	3,453

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons
January	4,121	4,983	4,395	4,316	3,558
February	3,823	3,555	3,780	3,372	2,755
March	3,562	3,839	3,653	3,696	3,286
April	4,066	4,087	3,619	3,177	3,251
May	4,319	4,135	3,823	3,729	3,413
June	3,993	4,303	4,048	3,435	3,489
July	4,245	4,582	3,544	3,517	...
August	4,620	3,591	4,046	3,732	...
September	4,379	3,623	3,932	3,636	...
October	4,409	3,908	3,797	3,681	...
November	3,976	4,085	4,059	3,635	...
December	4,614	4,351	4,071	3,945	...
	50,127	49,042	46,767	43,871	19,752

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1915	4,918	£448,362	£90 14 6
Year 1916	4,668	£478,194	—
January 2, 1917	176	£17,677	£100 8 10
January 15	$160\frac{3}{4}$	£16,681	£103 15 5
January 29	152	£16,095	£105 17 10
February 12	$182\frac{1}{4}$	£20,649	£113 6 1
February 26	$176\frac{3}{4}$	£19,700	£111 9 3
March 12	179	£20,468	£114 7 0
March 26	$161\frac{3}{4}$	£19,875	£122 17 8
April 10	179	£22,024	£123 2 0
April 23	169	£21,429	£126 16 0
May 7	167	£22,248	£133 4 6
May 21	$168\frac{1}{4}$	£23,772	£141 5 9
June 4	168	£22,474	£133 15 6
June 18	$158\frac{1}{2}$	£21,915	£138 5 4
July 2	$159\frac{1}{2}$	£21,661	£135 16 1
July 16	$144\frac{1}{4}$	£18,896	£130 19 11
July 30	168	£23,225	£138 5 0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:

	August 4, 1916 £ s. d.	August 7, 1917 £ s. d.
RAND:		
Bantjes	14 0	5 0
Brakpan	4 10 0	5 5 0
Central Mining (£8)	6 7 6	6 6 3
Cinderella	6 6	3 9
City & Suburban (£4)	1 19 6	1 12 6
City Deep	4 0 0	4 3 0
Consolidated Gold Fields	1 11 3	1 12 6
Consolidated Langlaagte	1 12 0	1 4 0
Consolidated Main Reef	19 0	16 6
Consolidated Mines Selection (10s).	18 6	1 5 0
Crown Mines (10s)	3 0 0	2 10 0
Daggafontein	14 9	16 3
D. Roodepoort Deep	13 9	11 3
East Rand Proprietary	14 3	7 9
Ferreira Deep	1 7 6	17 6
Geduld	2 4 3	2 0 0
Geldenhuis Deep	1 5 6	1 2 6
Gov't Gold Mining Areas	2 0 3	3 2 6
Heriot	2 7 6	1 12 6
Jupiter	8 3	4 6
Kleinfontein	1 8 6	1 0 3
Knight Central	13 9	3 3
Knight's Deep	1 5 0	13 9
Langlaagte Estate	18 9	16 3
Luipaard's Vlei	8 6	5 6
Main Reef West	7 6	4 0
Meyer & Charlton	5 6 3	5 6 3
Modderfontein (£4)	17 8 9	20 17 6
Modderfontein B	6 16 3	7 17 0
Modder Deep	6 16 3	7 3 9
Nourse	15 0	1 0 6
Rand Mines (5s.)	3 12 0	3 6 3
Rand Selection Corporation	3 10 0	4 0 0
Randfontein Central	10 3	12 3
Robinson (£5)	1 3 9	1 1 3
Robinson Deep	18 6	1 11 3
Rose Deep	1 5 6	18 9
Simmer & Jack	7 6	8 0
Simmer Deep	2 3	2 6
Springs	2 18 0	3 2 6
Van Ryn	2 0 0	1 15 0
Van Ryn Deep	3 10 6	3 8 0
Village Deep	1 11 3	1 3 0
Village Main Reef	15 6	15 6
Witwatersrand (Knight's)	2 19 6	2 2 6
Witwatersrand Deep	1 7 6	12 0
Wolhuter	10 0	8 3
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	15 0	17 6
Sheba (5s.)	1 9	1 3
Transvaal Gold Mining Estates	1 5 0	15 6
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	11 2 6	13 2 6
Jagersfontein	3 6 3	4 5 0
Premier Deferred (2s. 6d.)	5 2 6	7 10 0
RHODESIA:		
Cam & Motor	13 6	10 0
Chartered British South Africa	13 0	13 0
Eldorado	10 0	6 6
Falcon	14 3	15 9
Gaika	10 6	8 9
Giant	6 6	6 0
Globe & Phœnix (5s.)	1 5 6	1 12 0
Lonely Reef	1 3 9	1 4 6
Shamva	1 10 0	1 3 9
Wanderer (3s.)	1 6	2 3
Willoughby's (10s.)	5 0	5 3
WEST AFRICA:		
Abbontiakoon (10s.)	6 9	4 9
Abosso	9 6	8 3
Ashanti (4s.)	18 9	1 0 9
Prestea Block A	8 9	5 9
Taquah	19 0	17 6
WEST AUSTRALIA:		
Associated Gold Mines	4 3	3 0
Associated Northern Blocks	3 3	2 9
Bullfinch	4 6	2 0
Golden Horse-Shoe (£5)	1 17 6	1 17 6
Great Boulder Proprietary (2s.)	13 0	12 0
Great Boulder Perseverance	9	9
Great Fingall (10s).	1 9	1 3
Ivanhoe (£5)	2 3 9	2 2 0
Kalgurli	12 0	8 6
Sons of Gwalia	15 6	13 0

GOLD, SILVER, *cont.*	August 4, 1916 £ s. d.	August 7, 1917 £ s. d.
OTHERS IN AUSTRALASIA:		
Mount Boppy, New South Wales	10 0	6 0
Talisman, New Zealand	12 6	12 6
Waihi, New Zealand	2 2 6	1 16 3
Waihi Grand Junction, New Z'lnd	19 0	15 3
AMERICA:		
Alaska Treadwell (£5), Alaska	5 15 0	1 2 6
Buena Tierra, Mexico	13 0	10 0
Camp Bird, Colorado	8 6	6 3
Casey Cobalt, Ontario	6 0	10 6
El Oro, Mexico	9 0	9 0
Esperanza, Mexico	11 6	9 0
Frontino & Bolivia, Colombia	11 0	10 6
Le Roi No. 2 (£5), British Columbia	10 0	8 6
Mexico Mines of El Oro, Mexico	3 12 6	4 7 6
Oroville Dredging, California	16 0	15 9
Plymouth Consolidated, California	1 3 0	1 4 6
St. John del Rey, Brazil	15 6	18 6
Santa Gertrudis, Mexico	12 3	10 0
Tomboy, Colorado	1 2 6	18 6
RUSSIA:		
Lena Goldfields	1 16 3	1 15 0
Orsk Priority	1 2 6	1 0 0
INDIA:		
Champion Reef (2s. 6d.)	6 3	5 9
Mysore (10s.)	3 17 6	3 5 0
Nundydroog (10s.)	1 6 6	1 6 9
Ooregum (10s.)	1 1 0	1 0 3

COPPER:

	August 4, 1916 £ s. d.	August 7, 1917 £ s. d.
Arizona Copper (5s.), Arizona	2 0 0	2 9 6
Cape Copper (£2), Cape Province	4 0 0	3 17 6
Chillagoe (10s.), Queensland	3	3
Cordoba (5s.), Spain	3 0	3 0
Great Cobar (£5), N.S.W.	3 6	2 0
Hampden Cloncurry, Queensland	1 16 0	1 10 3
Kyshtim, Russia	2 10 6	2 0 0
Messina (5s.), Transvaal	11 6	10 6
Mount Elliott (£5), Queensland	3 17 6	5 10 0
Mount Lyell, Tasmania	1 6 0	1 5 9
Mount Morgan, Queensland	1 17 6	1 12 0
Rio Tinto (£5), Spain	61 5 0	62 0 0
Sissert, Russia	1 3 0	1 2 6
Spassky, Russia	2 3 0	1 15 0
Tanalyk, Russia	2 12 6	1 17 0
Tanganyika, Congo and Rhodesia	2 10 0	3 7 6
Tharsis (£2), Spain	5 0 0	5 0 0

LEAD-ZINC:

	August 4, 1916 £ s. d.	August 7, 1917 £ s. d.
BROKEN HILL:		
Amalgamated Zinc	1 13 0	1 13 9
British Broken Hill	1 4 6	1 17 0
Broken Hill Proprietary (8s.)	3 1 6	2 8 0
Broken Hill Block 10 (£10)	1 3 0	1 3 0
Broken Hill North	2 6 3	2 15 6
Broken Hill South	8 10 6	8 15 0
Sulphide Corporation (15s.)	1 6 6	1 6 9
Zinc Corporation (10s.)	15 0	1 1 6
ASIA:		
Burma Corporation	3 5 6	3 18 9
Irtysh Corporation	2 9 6	1 16 3
Russian Mining	1 3 9	16 3
Russo-Asiatic	6 3 9	4 5 0

TIN:

	August 4, 1916 £ s. d.	August 7, 1917 £ s. d.
Aramayo Francke, Bolivia	1 7 6	1 15 0
Bisichi, Nigeria	8 6	14 3
Briseis, Tasmania	4 9	5 0
Dolcoath, Cornwall	10 9	9 9
East Pool, Cornwall	1 16 3	2 12 6
Ex-Lands Nigeria (2s.), Nigeria	1 6	1 9
Geevor (10s.) Cornwall	6 3	13 3
Gopeng, Malay	1 10 0	1 12 6
Ipoh Dredging, Malay	17 6	14 6
Malayan Tin Dredging, Malay	1 18 9	1 17 6
Mongu (10s.), Nigeria	8 6	13 0
Naraguta, Nigeria	13 9	13 9
N. N. Bauchi Pref. (10s.), Nigeria	5 6	10 6
Pahang Consolidated (5s.), Malay	11 0	11 6
Rayfield, Nigeria	5 6	9 9
Renong Dredging, Siam	1 10 0	2 13 9
Ropp (4s.), Nigeria	16 0	17 0
Siamese Tin, Siam	2 11 3	2 17 6
South Crofty (5s.), Cornwall	16 0	1 0 0
Tekka, Malay	3 2 6	3 7 6
Tekka-Taiping, Malay	2 5 0	3 10 0
Tronoh, Malay	1 10 0	1 7 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE ASSAY OF TUNGSTEN AND ITS MINERALS.

We give herewith the second part of Mr. H. W. Hutchin's paper on tungsten read before the Cornish Institute of Engineers on June 2. The first part, reprinted in our July issue, dealt with the chemistry and metallurgy. The second part deals with the assays.

ASSAY OF TUNGSTEN.—The determination of tungsten is usually made by weighing as tungstic oxide (WO_3) resulting from the ignition of pure ammonium tungstate, basic mercurous tungstate, benzidine tungstate, etc. While fairly accurate determinations may be made by such means, a reliable volumetric method and, for the smaller quantities, a colorimetric method would be a boon. Of volumetric methods it has been proposed to dissolve precipitated tungstic acid in a standard solution of ethylamine instead of ammonia and titrate the excess with acid. The method does not appear to have been adopted, and with a practical knowledge of the properties of separated tungstic acid it would be correct to state that the method could at best have only a limited application.

Solutions of the tungstates acidified with hydrochloric or sulphuric acid are reduced by metals such as zinc and aluminium to lower oxides. The lower oxides may then be determined by standard solutions of oxidizing agents. The principal difficulty is in securing reduction to a definite lower oxide. If the reduction is controlled a blue compound is produced, but with over reduction a reddish compound is formed. The following are details of such a method published in the Transactions of the American Electrochemical Society, Vol. xiii, 1908: "To the solution of the alkaline tungstate containing not more than 0·1 of WO_3 add 70 to 80 c.c. hydrochloric acid, 15 grammes of stick zinc, and set on a steam bath. When the liquid has become red, it is cooled and decanted into a measured quantity of standard permanganate. This solution should contain manganese sulphate and dilute H_2SO_4 to counteract the action of HCl on the permanganate. The excess of permanganate is then determined by titration with a standard solution of ferrous sulphate." The same method appears in Sutton's Volumetric Analysis, 1890; hence it would appear that very little progress has been made along these lines.

Electrolytic determinations cannot be made, as a solution of normal tungstate is not electrolysed, and in hydrofluoric acid solution the change is to a lower form of oxidation only and not to metal. But it should be possible to use the electric current as a reducing agent in preference to reduction with metals, and then titrate with a standard solution of a suitable oxidizing agent. For small quantities of tungsten, reduction of the acid solution with zinc, aluminium, or by electrolysis and titration with some organic colour base such as methyl orange might be distinctly practicable and worth investigating. Volumetric methods based on titration with solutions of metallic salts are not applicable, partly by reason of their solubility or partly by the tendency to form more or less complex tungstates rather than normal metallic tungstates. In brief, the reactions are not sufficiently quantitative.

Colorimetric methods too are unsatisfactory. The blue compound produced by the action of reducing agents like $SnCl_2$, and the metals Zn and Al, is not developed until the solution contains an appreciable quantity of tungsten, and in addition there is the danger of over reduction to a still lower oxide of tungsten. For small amounts, reduction of the tungsten solution with stannous chloride by boiling and addition of KCNS solution to the cold solution gives a yellow coloration. This is a sensitive reaction, and molybdenum must be absent; 0·25 mg. WO_3 gives a distinct coloration in a volume of 50 c.c.; standard tints of 1, 2, 3, 4, etc. mg. may be prepared and are comparable in tint. The colour however fades on standing; standards made several hours later have a stronger coloration than the earlier ones. The degree of acidity (HCl) also affects the intensity of colour, and ferrous chloride rapidly bleaches it. For small quantities, however, the time for the extinction of colour might serve as a measure of the quantity.

The addition of potassium iodide and mercurous nitrate to a tungsten solution has been suggested as a delicate reagent: "To the neutral solution of the tungstate is added a drop of saturated solution of mercurous nitrate, then 1 c.c. of strong hydrochloric acid and further an excess of potassium iodide. When the precipitate of mercurous iodide has redissolved, mercury will deposit and the supernatant liquid will gradually turn blue." (See *Journal Chemical Society*, A.ii. 613-708, 1912). The reaction is also given by sodium tungstate solution in the presence of mercury and hydrochloric acid.

Tungstic acid gives a blue coloration when crystals of uric acid and a few drops of caustic soda solution are added. (*Ann. Chem. Anal.* 1914.) The action of organic reducing agents on tungsten solutions might with advantage be studied, with a view to a reliable colorimetric determination.

While the position with respect to methods other than gravimetric is weak, in that direction it is much more satisfactory, and it is on gravimetric lines that most progress has been recorded. In a review of gravimetric methods it is advisable to consider them as applied to minerals separately from the application to metallurgical products.

ASSAY OF TUNGSTEN MINERALS.—The earliest method, due to Wohler, is based on decomposition with aqua regia, when WO_3 separates out, solution of the WO_3 in ammonia to form ammonium tungstate, evaporation of the filtered solution, and ignition of the ammonium tungstate to WO_3. The following are the details: Reduce the ore to a very fine powder, weigh off one gramme and digest for 12 hours at a gentle heat with a mixture of four parts hydrochloric and one part nitric acid, till yellow pulverulent tungstic acid remains. Evaporate to dryness on the water bath, and take up with water acidulated by hydrochloric acid. Filter, wash the residue with alcohol, and treat the mixture on the filter with ammonia. Place the filtrate in a weighed porcelain, or preferably platinum, dish, evaporate to dryness on the water bath, and heat the residue of ammonium tungstate to decomposition. Weigh as WO_3 and calculate the percentage.

The tendency with modern workers has been in the substitution of an attack with hydrochloric acid for aqua regia. Details of the method with hydrochloric acid attack are given in the following quotations from a paper on the Assay of Wolfram Concentrate, by H. W. Hutchin, published in the ***Analyst***, August 1911 :

"To one grm. of the finely powdered wolfram in an 8 oz. beaker add about 10 c.c. strong hydrochloric acid, and agitate carefully to prevent caking. Add more acid (about 90 c.c. in all), cover with a clock-glass, and boil briskly until the volume of acid is reduced to about 5 c.c. Allow to cool, add 5 c.c. strong nitric acid, and digest at nearly a boiling temperature for from five to ten minutes. Dilute with water to about 100 c.c., allow to settle, and filter through a 9 cm. filter, wash with water, working so as to obtain as little tungstic acid as possible on the filter. To the beaker add about 10 c.c. distilled water and 10 c.c. dilute ammonia, adding the latter in small quantities down the sides of the beaker. With a rubber-tipped rod remove any deposit from the sides of the beaker into the alkaline liquor, raise to the boil, and stir well. If the suspended matter does not readily subside, boil again until the desired result is attained. Allow to settle, and while still hot filter through the original paper into an 8 oz. flask. Wash the beaker two or three times with small quantities of distilled water, decanting each time from any heavy mineral that may be present. Complete the washing of the filter-paper, and reserve the cover-glass, filter-paper, and beaker. Evaporate the solution of ammonium tungstate in the flask to a small volume, transfer carefully to a weighed platinum dish, and continue the evaporation to dryness on a water-bath. Ignite the dish and contents gently at first, and more strongly afterwards. Weigh as tungstic acid. To the beaker containing the heavy residues add 5 c.c. hydrochloric acid, cover with the original clock-glass, and boil till nearly dry ; add a few c.c. of nitric acid, and heat again for ten minutes. Dilute with water, allow to stand until the deposit has subsided, filter through a small paper, and wash the beaker and paper several times. Wash the filter-paper, also the original filter-paper, with a little hot dilute caustic soda solution, followed by small washes of distilled water, and collect the alkaline liquors and washings in a beaker. If the clock-glass is stained with tungstic acid, dissolve with a few drops of the soda solution and add to the contents of the beaker. Raise the contents of the beaker to boiling, add about 2 grm. ammonium nitrate, and stir well while boiling. Filter through one of the papers previously used, and wash a little. Nearly neutralize the filtrate with dilute nitric acid, add a few c.c. of mercurous nitrate solution, stir well, filter on a small ashless paper, wash, ignite, and weigh as tungstic acid. Add this weight to the weight of the tungstic acid in the platinum dish.

"Fine grinding is essential to success. One grm. is a convenient quantity, but with experience 2·5 grm. may be taken without requiring any modification of the quantities given in the assay. The complete decomposition with the boiling hydrochloric acid takes about one hour, but it is better to continue boiling if the volume of residual liquors is much more than 5 c.c. The addition of nitric acid, with further digestion, is a concession to custom, but it would seem from experiment that in some instances it is unnecessary ; for instance, two samples of wolfram gave 71·57 and 75·6% respectively, using nitric acid, and 71·6 and 75·54% respectively using no nitric acid. Departure from custom is not recommended without a more extended series of experiments. In filtering the acid liquors from the tungstic acid, etc., a special wash-water is unnecessary ; with water only, the filtrate and washings are free from dissolved tungstic acid. The instructions given for effecting the solution of the tungstic acid in ammonia are based on experience ; turbid filtrates seldom occur, and the volume of solution for concentration is reduced to a minimum, thereby saving time without sacrificing accuracy. With a turbid filtrate, it is better to continue the assay and determine the amount of impurity in the tungstic acid after weighing, as follows : Add sufficient distilled water to cover the tungstic acid in the platinum dish, and about 1 grm. of pure caustic soda. Digest on the water-bath for a few minutes, until all the tungstic acid has dissolved. Wash the contents of the dish into a suitable beaker, add 3 grm. of ammonium nitrate, boil, filter on a small ashless paper, wash, burn, and weigh. Deduct the weight from the original weight of tungstic acid.

"The re-treatment of the residues from the ammonium tungstate filtrate is the crucial point of the assay ; without it concordant results are rare, the residues being seldom free from tungstic acid. Its presence may be due either to unattacked wolfram or to tungstic acid retained by the residues. The former is due to defective powdering, and may be controlled ; with experience it is of infrequent occurrence. The retained tungstic acid does not appear to be within the control of the assayer, but proof of its presence is easy. Wolfram is not soluble in cold dilute caustic soda solution, whereas the retained tungstic acid is.

"By a modification of the above method the determination may be made by means of mercurous tungstate, which yields WO_3 on ignition. Proceed as described in the preceding method to the sentence ending 'wash with water, working so as to obtain as little tungstic acid on the paper as possible.' To the beaker add about 15 c.c. distilled water and 5 c.c. of 10% caustic soda solution ; cleanse the cover-glass with a few drops of very dilute solution, and wash into the beaker ; run a few c.c. of dilute soda through the filter paper, and wash with water, collecting the filtrate and washings in a beaker ; rub down any deposit above the level of the liquid in the beaker with a rubber-tipped rod, raise to the boil, add 3 grm. ammonium nitrate, and continue to boil for a minute or so. Allow to settle ; filter, and wash with weak ammonium nitrate solution, collecting the filtrate and washings in a large-sized beaker. Dilute to about 200 c.c. ; acidify with nitric acid first, then neutralize or make faintly alkaline with dilute ammonia. Add sufficient mercurous nitrate solution, and again neutralize with precipitated mercuric oxide ; stir well ; filter and wash by decantation ; finally transfer all precipitate to the paper and complete the washing. Dry, burn, and weigh as tungstic acid. The residues should be again treated with acid, etc., for unattacked wolfram."

The first of these two methods is well suited for the assay of high-grade wolfram concentrates, the second for the assay of mixed tin-wolfram concentrates from 30 to 40% WO_3 downwards, and for tin concentrates separated from wolfram. Either method is suitable for scheelite or wolfram, but a few rare tungsten compounds are met with, which are better assayed by a method involving fusion with alkali. In the United States preference is given to an attack with hydrochloric acid and hydrofluoric acids (see A. H. Low's Technical Methods of Ore Analysis, page 267) ; there are doubtless good reasons for the preference. Generally speaking, with a hydrochloric attack, providing the sample is properly floured, the decomposition is not difficult and is speedy ; with aqua regia decomposition is not so easy or speedy, and it is a dangerous method in the presence of arsenical minerals. Ignition of wolfram with (1) lime, (2) ammonium chloride and lime, (3) calcium carbonate and salt renders it easier to decompose with hydrochloric acid ; even dilute acid is sufficient in some instances. The case of decomposition is counterbalanced by undesirable features, namely : (1) a pronounced solubility of the tungsten in the acid liquors ; (2) the presence of arsenic even in small quantities increases the solubility and is difficult to recover.

Fusion with bisulphate of potash has been adapted by Cremer for the assay of wolfram ; 1 grm. is fused with bisulphate ; the solution of the melt is made with water acidulated with hydrochloric acid ; a concentrated solution of cinchonine is added, and boiled for a few minutes. Filter and wash with cinchonine water. Incinerate the paper and residue in a porcelain crucible to bright redness. Weigh, dissolve out the WO_3 with ammonia, and weigh the residue. WO_3 is calculated on the difference. WO_3 not too strongly ignited is soluble in ammonia.

Methods based on attack with alkalis are next to be considered. When fused with alkaline carbonates, caustic alkalis, or sodium peroxide, wolfram and scheelite are decomposed to form sodium tungstate which is soluble in water. Where scheelite is present and Na HO, KHO, or Na_2O_2 have been used the solution of the melt should be made to a known volume, preferably with water containing a little caustic alkali and a measured portion of the filtered solution taken for the actual assay ; complete extraction of the residue by the method of filtering and washing results in caustic lime passing through in the later washings with the precipitation of calcium tungstate. Other minerals besides wolfram are attacked in the alkaline fusion, and the method of assay has to be adapted to the circumstances.

The conditions and the method pursued when fusion is the mode of attack, are well presented by Bullenheimer in his article in *Chemiker Zeitung*, 1900, Vol. II, page 870, on the determination of wolfram in its ores.

"The determination of WO_3 in pure or highly concentrated ores does not offer any particular difficulties. If on the other hand low-grade ores have to be analysed, the accessory minerals may give rise to complications. Particularly As and P compounds (FeAsS and apatite) may much interfere, giving rise to the formation of arseno or phosphotungstic acid, in which case the WO_3 is either eliminated incompletely or in an impure state by the usual precipitants. The following descriptions of a number of determinations of WO_3 in ores, as well as the mode of working which has proved reliable, may be of interest.

"The decomposition of wolfram with aqua regia is lengthy and frequently incomplete. It is better to assist the decomposition by a melt, for which purpose Na_2O_2 is particularly suited, or by heating for several hours over a triple bunsen burner with a soda-nitre mixture, the first method being preferable. It was also attempted to do this by KCN and soda, but it failed owing to formation of tungsten bronze. The Na_2O_2 process after leaching yields a strongly alkaline lye and may contain, owing to the minerals present (scheelite, stolzite, cassiterite, mispickel, molybdenite, apatite, fluorspar, quartz, mica, and other silicates) beside Na_2WO_4, stannate, arsenate, molybdate, phosphate, and silicate of soda apart from other interfering substances. To get the WO_3 perfectly free from such a solution direct is an impossibility. If such a solution is boiled down with aqua regia to dryness we get in addition to WO_3, also SnO_2, SiO_2, MoO_3 and possibly also difficultly soluble phosphotungstates, arsenotungstates or molybdates. On the other hand, with precipitation with $HgNO_3$, the last named impurities are also brought down ; if made strongly acid, the H_3PO_4 and H_3AsO_4 may remain in solution when the precipitation of WO_3 is incomplete. The strongly acid solution of Na_2WO_4 with much H_3PO_4 will yield with $HgNO_3$ a precipitate which will go into solution on gently heating.

"The elimination of the interfering impurities is best performed in the following manner : The strongly alkaline solution is decomposed with NH_4NO_3 according to the equation :

$$NaHO + NH_4NO_3 = NaNO_3 + NH_4HO$$

at the same time allowing for an excess of ammonia salts. The SnO_2 and SiO_2 are separated, the latter perhaps not completely, but it will not interfere with further operations. At the same time the strongly alkaline solution is obtained for the separation of WO_3 from P_2O_5 and As_2O_5. If magnesia mixture is then added, any phosphates and arsenates are precipitated free from WO_3. In this manner a solution is obtained, which besides $WO_3 + MoO_3$ contains no bodies precipitated by $HgNO_3$. Upon acidulating slightly with HNO_3, and adding $HgNO_3$, $WO_3 + MoO_3$ are jointly precipitated, heated, and weighed as such. If no MO_3 is present this is easily accomplished, but if the latter is present, it must be repeatedly strongly heated ; the addition of NH_4Cl facilitates the volatilization of MoO_3.

"The mode of analysis is as follows : Place 1 to 2 grm. of ore in a nickel dish, with 4 grm. Na_2O_2 and 3 grm. stick soda. Heat first with a small flame until the whole is soft ; after a while heat with a full flame with constant stirring until the melt has become quite fluid and the bottom is red hot. Wolfram is easily decomposed, whereas cassiterite remains partly intact. After solidifying, the melt is dissolved in a beaker of water and made up to 250 c.c. If of a green colour add a little Na_2O_2 first. Filter, and to half the solution (125 c.c.) add 20 grm. NH_4NO_3. When the latter has gone into solution, the liquid is allowed to stand until the SnO_2 and SiO_2 have come down and if necessary the As and P precipitated by Mg mixture (nitrates must be used). After standing six hours the Mg precipitate, etc., is filtered off, and first washed with ammonia and then with water. It is absolutely necessary to allow the SiO_2 and SnO_2 to settle before adding the magnesia mixture, as otherwise the precipitate will easily contain WO_3. The ammoniacal filtrate is slightly acidulated with HNO_3, and after cooling 20 to 30 c c. of $HgNO_3$ is added (200 grm. and 20 c.c. concentrated HNO_3 and a little warm water—dilute to 1 litre and keep over mercury). A few hours later add ammonia till only slightly acid and allow to stand until the solution above the dark precipitate is clear. The precipitate is then collected on the filter paper and washed with dilute $HgNO_3$. If these precautions are taken the precipitate will never go through the filter, and the wash water will always remain clear. After drying, the precipitate is heated until the weight is constant. If much Mo is present, this will take longer ; NH_4Cl will accelerate this."

Bullenheimer's method is not so advantageous with very poor silicious or very arsenical material. With such material a fusion with caustic alkali may be replaced by a digestion with caustic alkali ; under such conditions the decomposition of the wolfram is accomplished without introducing large quantities of silica, arsenic, etc. (See Vol. xviii., Trans. I.M.M., page 425). The method appears in many of the text-books of assaying. Where caustic soda is used the method is applicable to wolfram only, as the attack on scheelite is never complete. Using caustic potash and care in flouring the sample, good results are obtained even in the presence of scheelite.

It is very desirable when using the mercurous nitrate method in conjunction with the alkaline attacks to determine the purity of the WO_3 after weighing. The separation of silica and alumina is sometimes incomplete, and may be weighed in with the WO_3 ; so too under certain conditions the WO_3 may contain As_2O_5. The purity may be checked as follows: The ignited oxide is digested in a small platinum dish or crucible with a little NaHO and a minimum of water till dissolved ; it is then washed out into a small beaker, ammonium nitrate added, boiled and filtered, the residue of SiO_2, etc., is burnt and weighed and deducted from the weight of crude oxide. To the alkaline filtrate is added magnesia mixture and the arsenic is estimated in the usual way. The weight of As_2O_5 is deducted from the original weight. More recently Wraight has suggested a bisulphate attack by fusion in conjunction with a mercurous nitrate determination.

Speaking generally the author's preference is for the hydrochloric acid method for the assay of high-grade wolfram concentrate, the fusion method for rare refractory products, the modified hydrochloric acid method for tin-wolfram concentrates, the soda digestion method for low-grade ores and tailings. With unknown material a cautious attitude should be adopted, and two or more wholly dissimilar methods followed, rather than a reliance upon duplicates by a particular method.

In one respect the methods for the assay of tungsten minerals are weak. The total tungstic acid is not over difficult to determine, but in a mixture of scheelite and wolfram it is difficult to arrive at the exact proportions of each. Where no other lime minerals are present it is possible to make an approximate determination by an estimation of the lime, and then calculating the equivalent of WO_3. A selective attack, such as boiling with dilute nitric acid naturally suggests itself, and with mixtures of cassiterite, scheelite, and wolfram would serve for the decomposition of the scheelite, except that experiment with wolfram alone indicates that a prolonged digestion with dilute nitric acid results in some attack. Again, experiment clearly proves that when scheelite is decomposed with dilute nitric acid in the presence of either mispickel or fluorspar considerable quantities of WO_3 pass into solution. This is clearly a weak point and one which calls for further investigation. The need for such discrimination frequently arises in connection with magnetic separation. In Cornish tin-wolfram concentrate it is settled by the assay of the +200 and —200 fractions of the separated tin, in the +200 the WO_3 rarely exceeds 0·25%, while the —200 may contain from 5% WO_3 upwards. Where scheelite does accompany wolfram the WO_3 in +200 and —200 fractions of the separated tin will be more nearly in equal proportions ; it is also possible in such cases to pick out whitish grains from the +200 fractions and test after powdering by boiling with dilute HNO_3 when yellow WO_3 separates out.

ASSAY OF TUNGSTEN PRODUCTS.—The metallurgical chemist has to deal with a wider range of products and problems than the chemist in the mine. The assay of tungsten metal, ferro-tungsten, products such as tungstate of soda, tungstic acid, residues from operations (such as residues from fusion with soda, slags, from thermo-electric methods, and from tin smelting), steel alloys, plain tungsten steel, more complex steels, such as tungsten-chrome steel, tungsten-nickel steel, all with or without molybdenum, and other alloys of commerce presents many interesting problems, which can only be dealt with in a general way.

In the assay of tungsten powder, in addition to a determination of the total tungsten contents, it is necessary to know the amount of oxide of tungsten, carbon, iron, manganese, silicon, sulphur, molybdenum, etc. For the total tungsten a suitable quantity, 0·5 grm., is ignited to oxide in a platinum crucible and silica removed by evaporation with HF. The residue is fused with carbonate of soda, dissolved in water, and filtered. The nearly neutralized filtrate is precipitated with $HgNO_3$, etc. Ibbotson and Brearley have given a method for the rapid evaluation of tungsten powders (*Chemical News*, Vol. 80, No. 2,091). It is worked on a charge of 3 grm., and advantages are claimed over the usual method. The article is well worthy of the consideration of those interested.

With regard to ferro-tungsten, the following is Fieber's method: 0·5 grm. of the finely powdered sample is treated first in a 250 c.c. beaker with 10 to 15 c.c. of bromine, applying a gentle heat; 30 c.c. strong hydrochloric acid are then added, and if necessary 5 to 10 c.c. of bromine. The excess of bromine is expelled by heating gradually on an asbestos plate, and in order to expel any silicon, 1 to 2 c.c. strong nitric acid and 2 or 3 drops of hydrofluoric acid are added. The solution is now concentrated as much as possible ; the residue is taken up with 40 c.c. of dilute hydrochloric acid (1 : 5), boiled, and allowed to settle. The precipitate is collected on a filter, washed alternately with hot water and dilute hydrochloric acid, moistened with ammonium nitrate, ignited, and weighed as WO_3. It should be tested for any silica by evaporation with sulphuric and hydrofluoric acid (*Journal* of Chemical Society 1912, A ii 401-504 ; original in *Chemiker Zeitung* 1912, 36, 334). Kuczynski advocates ignition in a current of chlorine gas as an alternative to bromine attack, or an attack with nitric acid of specified strength in the presence of ammonium fluoride (*Bull*. Acad. Sci. Cracow 1911, A 542-544 or *Journal* of Chemical Society 1912, Aii 109–212). Ferro-tungstens are amenable to attack by fusion with ammonium nitrate or bisulphate of potash.

For the estimation of tungsten in steel, the following is the method by Ibbotson and Brearley (*Chemical News* 1900, 82,224-225) : 5 grm. of drillings are digested with 100 c c. hydrochloric acid at near boiling point, nitric acid is added, drop by drop, at the end in sufficient quantity to convert ferrous iron to ferric. Boil until all WO_3 is precipitated, dilute, boil again, and allow to settle. Filter, wash, and calcine the precipitate and treat with hydrofluoric acid. The residue is fused with Na_2CO_3, dissolved in water, filtered, and WO_3 determined by $HgNO_3$ in the filtrate. Ferro-tungsten may be treated in the same way, but tungsten remaining in the acid filtrate must be recovered by evaporation and included. For nickel-tungstens an attack with nitric acid and hydrofluoric acid is recommended, the fluoride being expelled by a subsequent evaporation with sulphuric acid. The diluted solution is filtered, and the WO_3 weighed, and the nickel in the filtrate determined by the usual cyanide titration. Tungsten-molybdenum steels are treated in quantities of 2 to 3 grm. with hydrochloric and nitric acids, evaporated to a paste, boiled with dilute hydrochloric acid, the tungsten trioxide weighed, and the molybdenum estimated as lead molybdate. (For details of procedure for the molybdenum determination see *Chemical News* 1900, 81, 269-271 ; Ibbotson and Brearley).

According to Schoffel's method, 5 to 10 grm. of drillings are digested with a prepared solution of cuprammonium chloride until the precipitated copper has redissolved. The residue is oxidized by nitric acid, filter, and treat the calcined product with hydrofluoric acid. The impure tungstic oxide is fused with sodium carbonate, etc. The method is not very exact in the presence of chromium. Bagley and Brearley recommend a modification of Schoffel's method (*Chemical News* 1900, 82, 270-271): 5 grm. of the sample are digested at the boiling point and occasionally shaken with 50 grm. of crystals of cuprammonium chloride, 100 c.c. water, and 50 c.c. of strong hydrochloric acid; a little while after the precipitated copper has dissolved, the solution is filtered and the residue washed with dilute hydrochloric acid, ignited, silica removed by treatment with hydrofluoric acid, and the residue fused with sodium carbonate, etc.

According to Von Knorre's method, a benzidine solution is made by dissolving 20 grm. of benzidine in water, dilute to 400 c.c., add 25 c.c. strong hydrochloric acid. Heat and filter the brown solution and dilute to one litre. 1 c.c. of the solution is sufficient for 25 mg. of tungsten, but 20 to 40% excess should be used. Begin by adding to the solution to be analysed a little dilute sulphuric acid or alkaline sulphate, then add enough of the above solution. Filter after standing about 5 minutes, wash with a dilute solution of benzidine chlorhydrate, and calcine wet in a platinum crucible. If the precipitation is carried out by the addition of sulphuric acid, it is necessary to take for each centigram of H_2SO_4 one c.c. of benzidine solution.

In dissolving alloys of iron and tungsten it is necessary to avoid an oxidizing atmosphere by dissolving in absence of air, preferably in a Johoda apparatus, using dilute sulphuric acid (sp. gr. 1·17) or dilute hydrochloric acid. The tungsten remains in the metallic state in the residue. Wash with a little dilute solution of benzidine and fuse the calcined residue with carbonate of soda. Dissolve the melt in water, filter, neutralize with hydrochloric acid, acidify with dilute sulphuric, and precipitate with benzidine chlorhydrate, filter when cold, wash, etc. Benzidine tungstate is slightly soluble in hot solution, phosphorus does not interfere, chromium does, and the method is slightly modified when present, thus: the solution of the melt after fusion with carbonate of soda is acidified with hydrochloric acid, using methyl orange as indicator, and then boiled for some time to convert the tungsten into metatungstic acid. When cold the chromic acid is reduced by a solution of sulphur dioxide, and the tungsten precipitated with the benzidine reagent. (*Journal* of Chemical Society 1908, Aii 745-784).

Kantschew advocates a volumetric estimation of the precipitated benzidine tungstate. It is washed with a small quantity of water, filter and precipitate are mixed with water in a flask and titrated at 60°C with decinormal NaHO solution in the presence of phenolphthalein, the contents of the flask being boiled when the end point is approached in order to prevent the action of atmospheric carbon dioxide on the indicator. (*J.C.S.* 1915, Aii 349).

Other workers have in recent years extended the use of organic salts. Guthier and Weise advocate precipitation from an acetic acid solution at the boiling point with Busch's "nitron" acetate reagent. (*Zeitsch. Anal. Chem.* 1914, 53, 426–430). Kafka recommends certain aromatic amines (*J.C.S.* 1913, Aii 882). Jannasch and Bettges state that tungsten may be estimated in tungstates by precipitating as the trioxide with hydrazin chloride in the presence of free hydrochloric acid (*J.C.S.* 1904, Aii 517). Alpha-naphthylamine is recommended by Tschilikin (*Berichte* 1909); the conditions are summarized in the abstracts of the *Journal* of the Chemical Society 1909.

According to Bazin's method 2 grm. are fused in a nickel dish with 4 grm. of sodium peroxide and 3 grm. of caustic soda. The melt is extracted with water and the determination of the tungsten in the solution made as in Bullenheimer's method.

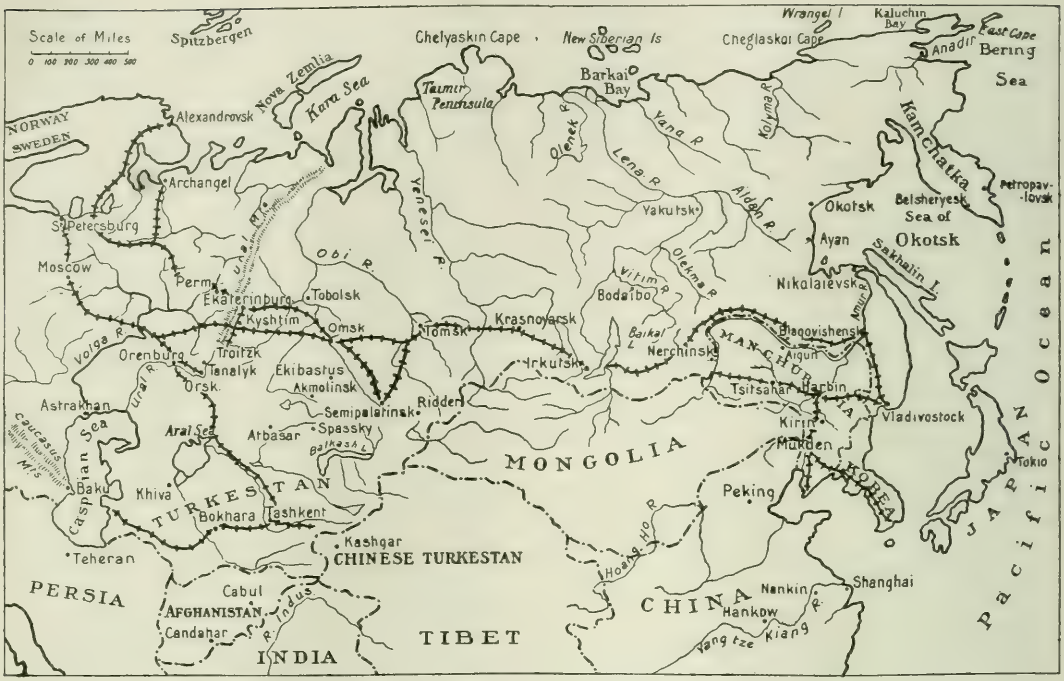
The assay of fairly pure tungstate of soda presents little difficulty, but when silico, phospho, or arseno tungstates are present special methods are necessary. For information on these points see the *Journal* of the Chemical Society.

The molybdenum-tungsten combination is of frequent occurrence in steel alloys. The assayer has to adapt his methods to a separation and determination of both metals. Brearley in conjunction with others has been a persistent and fruitful worker in this direction. Articles by him on molybdenum and tungsten compounds have appeared from time to time in the *Chemical News* of which abstracts appear in the *Journal* of the Chemical Society. The two metals are precipitated as lead tungstate and molybdate; on boiling the mixed lead salts with hydrochloric acid of suitable strength, the tungsten is precipitated as WO_3, and the molybdenum passes into solution. Other methods which have been proposed are: Boiling the mixed solution of sodium tungstate and molybdate with $SnCl_2$ when WO_2 is precipitated (Marbaker: *J. Amer. Chem. Soc.* 1915, 37, 86–95). By the action of warm sulphuric acid (sp. gr. 1·37) upon the mixed oxides (WO_3 and MoO_3), the molybdic oxide dissolving (Rugonburg and Smith J., *Amer. Chem. Soc.* xxii. 772). By heating the mixed oxides with hydrochloric acid gas at 250°–270°, when the molybdenum is volatilized (Pechard, *Compt. Rend.* cxiv. 173). By precipitation of the sulphide of molybdenum by means of hydrogen sulphide in the presence of tartaric acid (Rose, *Handbuch der Anal. Chemie* 1871, 358).

THE APPROACHES TO RUSSIA FROM THE PACIFIC.

On May 17, Mr. C. W. Purington delivered a lecture before the United Russian Societies Association on the Pacific Routes to Siberia. The eighteenth century was the period when explorers issuing from the harbours of Ochotsk and Petropavlosk examined the eastern coastline, followed the coast along the Arctic sea to the westward, and, in the other direction, made settlements in Alaska. Those pioneers are nowadays almost forgotten except among the geographers, and the possibilities of the coast and of internal communications are little appreciated. Vladivostok and Nikolaievsk, the only settlements which in the early days pretended to the name of sea-ports, remained nevertheless up to the time of the Russo-Japanese war as little more than fishing villages. As for Anadir and Ochotsk, founded in the 17th century, Port Ayan, Petropavlovsk, and Bolsheretsk, they remained and still remain desolate and unattractive semi-official, semi-native outposts of civilization, though destined some day to become of world-fame and importance as some of Russia's eastern windows to the world.

Mr. Purington pictures the old type of Siberian merchant adventurer, who traversed the Pacific in the frail "shittiks," or sewn boats, in the early 18th century. Notable among the early traders were Trapeznikof and Solovief, merchants of Irkutsk, whose descendants in the 19th century became pioneers in gold-mining in the Northern Taiga of Yenesei, and after-



Sketch Map to Illustrate Means of Access to Russia from the East.

wards in the mountains of the Vitim. Another name notable in these expeditions was that of Glotof, whose descendants to-day run a line of steamers on the Lena river. The author then takes us through the early fur-trading exploits, and then proceeds to speak of the possible eastern ports of approach to Siberia. The biggest ships can anchor with safety at Ayan, Petropavlovsk, and Anadir. The Russians reached Ochotsk by land, after travelling 12,000 miles from Petrograd, in 1647, and although for 270 years Ochotsk has been asleep, it is well to remember that the Russians are to-day railway builders. The distance from either Ochotsk or Ayan to Yakutsk, on the Lena river, is less than 500 miles. The existing Amur railway, connecting up the great grain fields of the Blagoveshensk plateau, approaches to within 700 miles of Ayan. Both Yakutsk and the Zeda are immense grain and cattle regions, and the former, on the 62nd parallel, although sparsely cultivated, is said to vie in fertility with Saskatchewan. The sea haul from Vancouver, or Prince Rupert, is shorter to Ayan in the Ochotsk Sea than to Yokohama, the distance being 3,300 miles from Vancouver to Ayan as against 4,320 from Vancover to Yokohama. There is an additional 1,200 miles to add from Yokohama to Vladivostok, for heavy freight going by the regular steamer route via Japan. The distance between Ayan and Petrograd is 600 miles shorter via Ayan, Abazin, north of Baikal, and Krasnoyarsk than the present route via Vladivostok and Irkutsk. Thus freight destined for points in Siberia east of Krasnoyarsk from Western Canadian ports will save on the total haul from 2,000 to 2,500 miles by the Ayan route as compared with the present roundabout route via Vladivostok. The northern route between Ayan and the junction point near Krasnoyarsk, has a great advantage in that it traverses a dissected plateau region where there are no heavy grades, whereas the present trans-Siberian route from Vladivostok traverses at least three mountain ranges, and the alternate route via Nikolaievsk, Amur river, and Sretensk presents difficulties which render transport equally expensive. A comparatively inexpensive improvement in transport would be the construction of an automobile road having a length of 100 miles from Ayan to connect with the Maya river which is a tributary to the Aldan, itself a tributary of the Lena.

Mr. Purington then proceeded to discuss the Arctic routes of transport, taking first the route by the mouth of the Lena river. It is probable that the cost of transport to points on the Upper Lena river from foreign ports of shipment would be practically cut in half if the Arctic sea route could be developed. Cossack travellers in the 17th century went in small boats without map or compass from Yakutsk on the Lena to the mouths of the Yana and Kolyma, from 1,200 to 2,000 miles to the eastward. In 1736, Laptef left the Lena, and proceeded westward as far as Cape Thaddeus, only 60 miles east of Cape Chelyaskin. In 1848 a trader named Dezhnef is reported to have sailed from Yakutsk in a small boat to the mouth of the Lena, and to the eastward round the East Cape, through the Bering sea to the Anadir river. This claim has been discredited on account of the vagueness of the records. Bering, in 1728, sailing from Petropavlovsk in Kamchatka, penetrated the strait which now bears his name, and proceeded westward for a short distance. In 1761, Shalaurof, a Russian merchant of Yakutsk, made a journey from that town down the Lena, as far eastward as Chaun Bay, but he was unable to double Cape Shelagskoi immediately to the east. Liakhoff, another Yakutsk merchant, discovered the New Siberian Islands off the Lena mouth in 1771. After that for many years, especially after the further exploration of these islands by Hedenstrom in 1809, there were numerous Russian expeditions out of the Lena to the islands in search of mammoth ivory, which exists there in great quantity. In recent years the islands have been systematically explored by the late Baron Toll.

In 1879, Nordenskjold made the trip from Gothenburg, Sweden, to Yokohama, in the "Vega." One of the financial backers of Nordensjold's enterprise was Michael Sibiryakof, the picturesque Siberian gold miner, who in 1862 staked the fabulously rich Blagoveshensky claim on the Bodaibo river, from which he made a fortune. The "Lena," a ship accompanying the "Vega," parted company at one of the mouths of the Lena, and proceeded up stream, 1,800 miles, or to within 350 miles of Bodaibo, on the Vitim, the centre of the rich goldfields of the Lena. The Vega doubled Cape Chelagskoi, and at the end of the summer was caught in the ice at Kaluchin Bay, proceeding on her voyage to Yokohama the following year. During the past five years the "Kolyma," a Russian transport, has twice made the journey from Vladivostok to the Kolyma river mouth and back. The recent voyage of Captain Vilkitsky from Vladivostok to Archangel has solved the problem of the northern trip in a westerly direction. Mr. Copley Amory, of New York, has given an account of a voyage which he, with six other men, made in 1914-15 from Seattle to Nizhne Kolymsk at the mouth of the Kolyma river, in a 60 ft. fishing schooner driven by petrol engines. They left Seattle, Washington, in June 1914, proceeded by way of Nome, Alaska, to the Kolyma, wintered there, and returned to Seattle in the summer of 1915. From the evidence of the various explorers it would appear that the great sea lying between Taimir peninsula and Bering strait is relatively free from ice, possibly on account of the immense discharge into it of water comparatively warm from the Lena, Yana, Olenek, and Kolyma rivers; that the journey from Bering strait to the New Siberian islands, and consequently to the east mouth of the Lena, can under favourable conditions be performed in less than a month, and that a deep bay, Borkai, directly to the east of the Lena mouth, affords anchorage and harbour for the unloading of ships and transfer of freight to river barges.

[Mr. Purington's paper was illustrated by an up-to-date map of the world, containing details of Russian geography and demonstrations of the comparative distances between the eastern and northern Russian ports and the rest of the world. Our pages are too small to do justice to this map, and we have been reluctantly obliged to use a very poor substitute which has already done service in our pages. This map is a mere sketch and not by any means accurate in all details, but it will serve to indicate the positions of towns, rivers, and capes mentioned by Mr. Purington. Owing to its imperfections, we wish to absolve Mr. Purington from all responsibility in connection with its preparation.—EDITOR].

Gold Metallurgy at Pilgrim's Rest.—The April *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa contains a paper by Robert Lindsay on the treatment of the gold ore mined by the Transvaal Gold Mining Estates at Pilgrim's Rest in the eastern Transvaal. The copper in the ore provided opportunity for research and discussion. The deposits have been worked for over 30 years. The ore consists of horizontal sheets of quartz in dolomite. It is oxidized, comparatively soft, honeycombed, and contains much hydrated oxide of iron, with some blue and green carbonates of copper, and occasionally undecomposed sulphides. The gold is in an extremely fine state of division, and the gold and iron go together, the ore highest in iron being the most valuable. The ore is sent to stamps, passed over amalgamating plates, re-ground in tube-mills, passed over a second set of plates, and divided into sand and slime. In the cyanide treatment, weak solutions are used, the average content being 0·04% KCN, in order to dissolve as little copper as possible. The time occupied in treatment is therefore correspondingly longer. The precipitation of the gold from the solutions requires special attention, for copper readily deposits on the zinc and stops the recovery of the gold. The zinc is therefore coated with lead by dipping it in lead acetate. The lead-zinc couple thus formed reduces the amount of copper precipitated.

The object aimed at is not to precipitate all the copper, but to keep the amount of copper in solution more or less constant. If the lead coating be too light, too much copper will be thrown down, and more zinc will have to be added to the extractors before clean-up is due, resulting in unnecessarily high consumption of zinc. The practice in dipping is to regulate the quantity of zinc dipped with the strength of the lead solution so that each 100 lb. of zinc carries 5 lb. metallic lead. That suits the copper content of the solution and precipitates about one-half of the copper entering the extractors, while the gold value of the effluent is seldom above 0·03 dwt. even in the cold season. Increasing the cyanide strength as a remedy for bad precipitation is not recommended. It gives temporary relief, no doubt, by keeping copper in solution, but the gradual accumulation of copper in solution detrimentally affects extraction, and the excess copper has to be got rid of eventually, either by precipitation or running some of the solution to waste. If the soluble copper content of the ore should become abnormally high, it will be found advantageous to have uncoated zinc in the first compartment to precipitate a proportionally large amount of copper, leaving the remaining compartments of lead-coated zinc to precipitate the gold and a portion of the remaining copper. The first compartment of coppery zinc is taken out every 4 or 5 days and immersed in dilute acid for a few minutes, and returned to the box along with some new zinc to fill the compartment. There is an increase in zinc consumption, but the gold precipitation is good.

The precipitation of copper on zinc is accompanied by a regeneration of cyanide, thus:

$$Cu_2(CN)_2, 4NaCN + Zn = 2Cu + Na_2Zn(CN)_4 + 2NaCN,$$

or

$$Cu_2(CN)_2, 6NaCN + Zn = 2Cu + Na_2Zn(CN)_4 + 4NaCN.$$

Consequently the cyanide strength leaving the extractor box is always higher than at entering it.

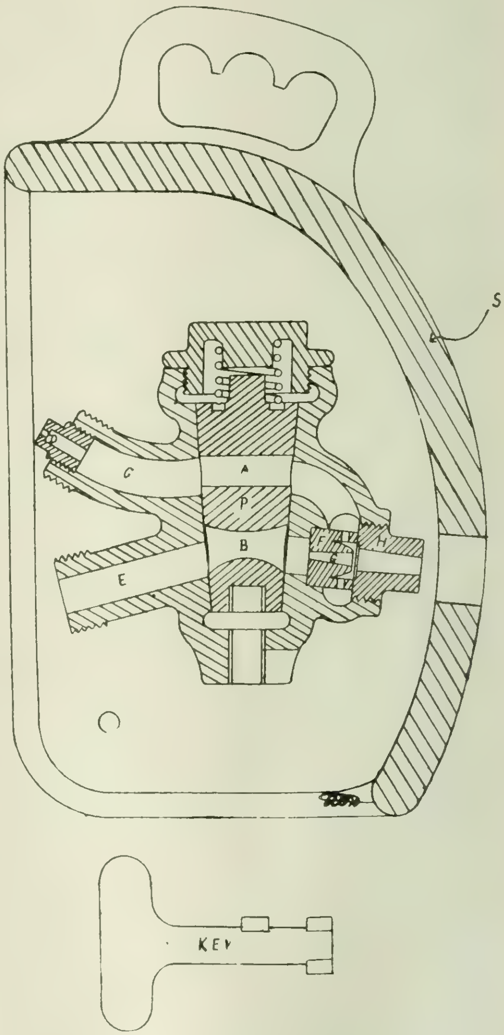
The clean-up takes place twice a month. The top compartment only of each box is taken out and treated as usual with sulphuric acid. Bisulphate is not used on account of difficulty of transport and inconvenience of handling, the mine being about 10 miles from the nearest railway station at Graskop. When all the zinc has been dissolved, the copper is attacked by nitric acid, or with sulphuric and nitric acids together, which is much cheaper than nitric acid alone. Over 700 lb. of copper is dissolved out every clean-up. The acids are added in the proportion of 1 part sulphuric to 0·44 part nitric acid, and the temperature should not be under 60° C. if copper is to be kept out of the bullion. The precipitate, kept in suspension by mechanical stirrers, is tested for the presence of copper after each addition of acid, so as to ensure no more acid being added than is absolutely necessary. When the copper is all in solution the vat is filled with water and a few pounds of size added to assist settlement, which usually takes place in five or six hours. The solution containing the zinc and copper is passed through a sand filter to catch any fine gold slime in suspension. The surface of the vat is skimmed every other month and the sand used as flux. The solution now flows through a stoneware pipe to two copper-precipitating vats, which are filled with scrap iron. Old iron is put into these such as fire-bars, fire-doors, worn-out plates, battery screening, etc. Every four months the vats are cleaned out and the precipitate is screened to remove coarse iron. It is air-dried, thoroughly mixed, sampled, assayed, and bagged. The following are the details of a parcel of this precipitate sent to England last July, and on which a net profit of £600 was realized :

Dry	Assay per Ton.			Total Content.		
wt. Tons	Au. oz.	Ag. oz.	Cu. %	Au. oz	Ag. oz.	Cu. Tons
8.171 ...	10·99	123·79	40·95 ...	89·802	1,011·550	3·346

There is no gold or silver in the copper vat effluent, and only a trace of copper toward the end of the run. It is found that coarse iron gives a much purer product, and by using that exclusively it is hoped to bring the precipitate up to over 60% grade. The copper recovered is equal to 0·13 lb. per ton milled, and agrees fairly closely with the difference between the copper content of originals and residues, and is rather less than one-half of the copper content of the ore for that period.

Tungsten at Essexvale, Rhodesia. — A report by A. E. V. Zealley has been published by the Rhodesian Geological Survey, describing the wolfram deposits at Essexvale, in the Umzingwane district, and about 20 miles east of Bulawayo. The deposits were discovered in 1906, and have been worked in a desultory manner, but only in the loose rock on the surface. Veins have been disclosed underneath the rubble, and worked for a few feet down. Owing to operations being on a small and primitive scale, they have not been profitable so far to continue in depth. The tungsten-bearing tract occupies the central portion of an oval mass of hornblende granite measuring 8 by 5 miles. This granite appears to dip below the surrounding epidiorite and felsite. Throughout this granite are found greisen dykes or lodes, and it is in these that wolfram and scheelite are found. The dykes contain lenses of quartz, and the tungsten minerals are usually found in their proximity. The size of the minerals is sometimes great, and a group of crystals of wolfram weighing 172 lb. is in the Rhodesia Museum. The tungsten occurs chiefly as wolfram, but scheelite is also present. The two are often intimately associated, and the miners, not recognizing the scheelite, break it off and throw it away. Mr. Zealley is of opinion that the greisen is the result of the action of vapours on an aplite, and that the aplite was injected along joint-planes caused by the contraction of the granite on consolidating, and not in fissures caused by faulting.

Allaying Dust by Water Spray.—The May *Journal* of the South African Institution of Engineers contains a paper by A. C. Whittome and J. H. Veasey describing the author's methods of dust prevention as tested at the Apex section of the New Kleinfontein company's property in the Far East Rand, together with an account of the "Apex" atomizer. The authors hold that by judicious arrangement of water sprays, not only is the dust caught and deposited, but the ventilation current can be regulated and the air cooled. The particles of water of which the spray is composed should be of such a size that the maximum amount of finest dust is caught. This result is obtained when the particles reach the ground 30 ft. or so from the atomizer ; this size is best obtained by $\frac{1}{8}$ in. apertures in the atomizers. Arrangements are made for controlling the action of the atomizers throughout the workings after each blast and for recording the fact that they have been brought into use. The illustration shows the atomizer as suitable for suspension from the hanging wall. The shield *S* is of cast iron



THE APEX WATER-SPRAY APPARATUS.

and the rest of the apparatus of gun metal. The passages *A* and *B* in the plug carry the water and compressed air respectively. The rotation of the plug turns on both the water and air. In the water passage *C* there is a removable diaphragm *D*, the aperture of which can be varied to regulate the quantity of water delivered to the mixing chamber between the cones *F* and *H*. The air is led through *E* and the passage *B* to the air-regulating cone *F*, the size of the aperture *G* in the cone determining the amount of air passing through. The water is atomized in the mixing chamber, and issues from the hole in the front cone *H* in a stream, at a velocity depending on the size of the hole in the cone. Variations in the size of this hole permit of a greater or smaller diameter of water-particle being produced, and also allow the stream of particles either to be projected to a considerable distance before it expands to the full width of the working or to spread out immediately in front of the shield. Thus the conditions are governed by the apertures *D*, *F*, and *H*. These are of standard interchangeable parts. Each atomizer throughout the mine has its individual numbered key. These keys can only be removed after turning on the water and air. When ready for a blast, the atomizers are all turned on, and the keys brought to the surface. In this way the number of atomizers in operation is indicated. The supply of water and air can, of course, also be turned on and cut off at the surface.

Fused Silica.—We have referred on other occasions to the use of various materials that withstand the attacks of acids and other chemicals. Last month reference was made to the iron silicon alloys, which are in extensive use in chemical plant. Another substance that is nowadays attracting the attention of the industrial chemist is fused silica. For three-quarters of a century the research chemist has attempted to make his "glass" instruments of this material, first employing the oxy-hydrogen blowpipe and afterwards the electric furnace for the purpose of their manufacture. Shenstone, in England, and Heræus, in Germany, early in this century, commenced the manufacture of tubes and other forms by means of the electric furnace, of a size large enough for the industrial chemist. The early work was done with pure rock crystal, but latterly sand averaging over 99% SiO_2 has been employed. The Thermal Syndicate, Limited, of Wallsend, near Newcastle-on-Tyne, has for some years been making fused silica articles on a commercial scale. The product is known under the trade name of "vitreosil." In 1910 a German firm, Ludwig Bolle & Co., publicly claimed to be the first to make these articles, but as a matter of fact the firm was only agents for the Wallsend products The *Journal* of the Society of Chemical Industry for June 15 contains a paper by Dr. Frank Bottomley recording the history of fused silica, and giving an outline of the practice at Wallsend.

In the first experiments carried out at Wallsend in 1903, attempts were made to obtain a mass of molten quartz or sand in a liquid state and to work it much in the same way as glass is worked, but it was soon discovered that this was out of the question. Although it is difficult to get silica really fluid, it can be obtained in a plastic condition much more readily. After a large amount of experimental work had been done, methods were evolved for working it in this condition. An electrical resistance furnace is employed, the heating core or resistance consisting of plates, tubes, or rods of carbon or graphite. The limits within which such furnaces can be worked are narrow, because the temperature at which silica reacts with carbon to form carborundum is close to the temperature required for working silica. The electric furnace, however, renders it possible to control the temperature of fusion, as accurate measurements are relatively easy. In the manufacture of tubes or pipes the starting point is a hollow cylinder of plastic silica; this is formed by fusing a mass of sand round a central core through which the current is passed. The size of the cylinder is decided by the amount of electrical energy passed through the core and the length of time the heating is continued. As soon as the hollow cylinder has been formed, the heating core is withdrawn from the centre of the mass, which can then be removed from the furnace and drawn into tubing. If a moulded article such as a pipe is required, the hollow plastic cylinder is closed at one end by mechanical pressure, and a refractory nozzle, to which a source of compressed air is attached, is pressed into the other end; the fused mass is then placed in the mould and expanded with compressed air until it assumes the required shape. The weight of fused material which can be worked at the present time exceeds 200 lb. The temperature required for fusing silica is between 1,800° and 2,000° C. In the plastic condition it is extremely ductile and can be drawn out like glass in lengths of 90 to 100 ft. The material made by this process is rough on the outside, but small laboratory ware is subjected to a further process of grinding and finally glazing by melting the surface. This may be done electrically or by an oxy-hydrogen blowpipe. Unfortunately, owing to the extreme viscosity of plastic silica, it is difficult to remove the fine air bubbles which are found mixed with and contained in sand, and this has so far prevented the material from being entirely transparent, though great improvements are being made in this direction. The lustrous appearance of some of the material is due to reflection from the included air. The specific gravity of fused silica made from sand is 2·07, as compared with 2·2 for that made from rock crystal. The co-efficient of expansion of the two materials is practically the same. A rod 1 metre long heated from 0° to 1,000° C. expands 0·5 mm. Fused silica is unattacked by practically all acids, except hydrofluoric acid and phosphoric acid, the latter only when the temperature is above 400° C., and at the same time on account of the small co-efficient of expansion it is able to resist extreme changes of temperature without cracking. These properties make it of great value for the manufacture of chemical plant. The author proceeds to give details of plant used in the concentration of sulphuric acid and the condensation of nitric acid.

Costs with Nissen Stamps.—In the January issue of the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa, K. L. Graham gives details of the comparative cost of stamp-milling with Nissen and California stamps at the Modderfontein B mine in the Far East Rand. It will be seen from the table that the Nissen stamp scores. The comparison is particularly reliable, for the time chosen for the tests covered periods when the two plants were of approximately the same age. The period covered by the test with the Californian stamps extended over the year 1913, and that with the Nissen stamps over the twelve months from September 1915 to August 1916.

COSTS IN PENCE PER TON.

	Californian.	Nissen.
	d	d.
White Wages	1·773	0·945
Coloured Wages	0·402	0·464
Coloured Labour Sundries	0·281	0·292
Mill Spares	0·922	1·296
Shoes and Dies	0·909	
Water	0·053	0·309
Sundry Stores	0·434	0·239
Workshops	0·487	0·272
Power	2·857	2·033
Total	8·118	5·850
Difference	2·268	
Tons milled	404,580	167,644
Number of Stamps	80	16

Molybdenum Production in Canada.—In the *Bulletin* of the Canadian Mining Institute for June, E. P. Grant gives particulars of the molybdenum industry conducted by the International Molybdenite Company.

This company operates its own mines, and also purchases ores, the amounts from these two sources being about equal. The ores come from Ontario, Quebec, and British Columbia, and they vary considerably in character; some contain more pyrite and allied sulphides than others, and some are highly micaceous; the British Columbia ores are purer, but the flakes of molybdenite are smaller. The capacity of the new concentrating plant, which was built last year at Renfrew, Ontario, is about 60 tons per day. The ore is first crushed to from 20 to 60 mesh according to circumstances, and the molybdenum flakes are caught on the screens. The crushed material then goes to flotation plant where an average recovery of 85% is obtained. The concentrates are sent by rail to the company's metallurgical works at Orillia. They are first treated for the production of ammonium molybdate, which is charged with iron into the electric furnace. The production of ferro-molybdenum, since the start in October 1916, has averaged two tons per 24 hours. The ferro contains from 70 to 76 molybdenum, 3% carbon, less than 0·1% sulphur, and no phosphorus or copper. This is delivered to the Imperial Munitions Board. In the chemical department, pure molybdic acid and ammonium molybdate are made, and are sold for laboratory purposes in Canada and the United States. It is notable that, as the company treats its own concentrates, there is no need to produce the high-grade concentrate, 90% MoS_2 or over, usually demanded by buyers, and the average product contains 60 to 70%.

Flotation at Cobalt, Ontario.—The *Bulletin* of the Canadian Mining Institute for June contains a paper by J. M. Callow and E. B. Thornhill on flotation practice in connection with the silver ores at Cobalt, Ontario. The first experimental Callow plant on a commercial scale was started toward the end of 1915 at the Buffalo mine. This was followed a year afterward by the erection of a plant having a capacity of 600 tons per day. The McKinley-Darragh-Savage company started a Callow plant in June 1916. Other companies using this system are the Nipissing, Coniagas, Dominion Reduction, Northern Customs Concentrators, and National Mines. The function of flotation in connection with Cobalt ores is to save the more friable silver-bearing minerals and the fine leaf-silver which are not caught by jigs or tables. The writers are of opinion that flotation will displace cyanidation in the treatment of low-grade ores and tailing. It is probable also that a method of extracting the silver locally will be established by the Buffalo and the McKinley-Darragh-Savage companies, instead of selling the concentrate to smelters. An idea of the performance of the Callow plant may be gained from the figures at McKinley-Darragh-Savage. During December and January the feed averaged 6·37 oz. per ton, the tailing 1·14 oz., and the concentrate 357·6 oz., this representing a recovery of 82·13%. It is necessary to grind fine, not more than 1 or 2% being retained on a 100 mesh screen. The usual oil mixture employed consists of 15% pine oil, 75% coal-tar creosote, and 10% coal tar. Tests of recoveries of the individual minerals show that 95% of the metallic silver is recovered, and that the sulphides, arsenides, and antimonides yield from 69 to 92% of their silver content, the average being 85%. The smelter charges on the concentrate are high, being quite 20% of the value of the metallic content. At the present time, experiments are being conducted with chloridizing-roasting followed by leaching. For this purpose, a Holt-Dern furnace (described in our issue of October 1914) is employed. After roasting, the base metals are extracted by an acid leach, and then the silver chloride is extracted by a cyanide leach.

Cobaltcrom.—In our July issue we referred to a patent for a tool-steel bearing this name. Further information is given in *Engineering* for July 6.

The Industries of Poland.—The *Engineer* for July 6 contains an article with map, describing the industries of Poland, giving special attention to the mineral products and resources.

Sands Used in Metallurgical Practice.—Dr. P. G. H. Boswell's paper, read at the annual meeting of the Society of Chemical Industry, held in July. The author has been engaged by the Minister of Munitions to undertake the investigation of British resources of these sands.

Metallurgy of Ferro-Manganese.—R. J. Anderson. *Engineering and Mining Journal*, June 2.

Metallurgy of Ferro-Silicon.—R. J. Anderson. *Engineering and Mining Journal*, June 23.

Mining Problems on the Rand.—H. Foster Bain. *Mining and Scientific Press*, May 26 and June 2.

Pneumatic Concentrator and Amalgamator.—F. A. Stanley, *Engineering and Mining Journal*, June 9.

Mining Industry of Peru.—F. C. Fuchs. *Engineering and Mining Journal*, June 9.

Zinc in 1916.—In the *Engineering and Mining Journal* for July 7, W. R. Ingalls gives his revised estimates of the production of zinc in the United States during 1916, together with statistics of the producers and their capacity.

Sulphur as a Fertilizer.—The *Mining and Scientific Press* for June 16 contains an article by P. J. O'Gara describing the effect of sulphuric acid and elemental sulphur as fertilizing agents when added to soils.

Copper Refining.—*Metallurgical and Chemical Engineering* for June 15 contains an article by Lawrence Addicks on Impurites in Electrolytic Copper Refining.

Potash from Beet.—*Metallurgical and Chemical Engineering* for July 1 reprints a paper by H. E. Zitkowski on the recovery of potash from waste liquors in the beet-sugar industry, read before the American Institute of Chemical Engineers at the June meeting.

RECENT PATENTS PUBLISHED.

7,727 of 1916 (106,669). W. J. Gee, London. Improvements in the inventor's centrifugal separators, which have been applied to the treatment of china-clay.

9,726 of 1916 (106,890). W. Feldenheimer, London. Adding carbonate cf soda to the water used in purifying china-clay; the inventor finds that this addition retards the deposition of the clay but does not interfere with the deposition of mica and other impurities.

9,590 of 1916 (107,265). A. Nihoul, late of Brussels. Improvements in the inventor's process for producing zinc carbonate suitable as a pigment from zinc residues, by treatment of the latter with hydrochloric acid and boiling with zinc dust to separate impurities, such as lead, tin, and cadmium, treating the solution with chlorine and zinc carbonate, and, after filtering, treating with carbonic acid in the presence of magnesium carbonate.

11,138 of 1916 (107,285). R. J. Shoemaker and J. C. McClintock, Topeka, Kansas, U.S.A. A method of coating iron with lead.

14,760 of 1916 (102,142). A. J. F. de Bavay, Melbourne, Australia. A condenser for zinc-distilling furnaces, consisting of several sections, which act successively as refining agents. The vapours from the retorts are made to pass through molten zinc, at gradually decreasing temperatures, and the lead and other impurities are thereby gradually removed.

15,447 of 1916 (107,324). A. A. ROBERTS, London. A method of treating strontium sulphate mineral for the purpose of producing a white pigment.

1,296 of 1917 (107,175). UTLEY WEDGE, Ardmore, Pa., U.S.A. Improvements in methods of feeding ore to roasting furnaces.

3,792 of 1917 (107,185). HUNTINGTON, HEBERLEIN & CO. and H. C. BINGHAM, London. Method of discharging roasted ore from mechanically-operated furnaces.

NEW BOOKS

The Analytical Distillation of Petroleum. By W. F. Rittman and E. W. Dean. Bulletin 125 of the United States Bureau of Mines. This pamphlet contains a record of experiments having for their object the establishment of a standard method for the fractional distillation of petroleum for analytical purposes.

Sampling Metallic Metallurgical Products. By Edward Keller. Bulletin 122 of the United States Bureau of Mines. This pamphlet of 100 pages contains a detailed discussion of the methods of sampling metal and bullion, particularly copper bullion.

Molybdenum : Its Ores and their Concentration. By F. W. Horton. Bulletin 111 of the United States Bureau of Mines. This pamphlet of 120 pages gives particulars of molybdenum minerals, the uses of the metal and its alloys and compounds, the methods of concentrating the ores, and the occurrence of the ores in various parts of the United States.

Rubber-Producing Companies, 1917. This yearbook is compiled by the Mincing Lane Tea & Rubber Sharebrokers' Association, and is published by *The Financial Times*. The price is 3s. 6d., and it contains 600 pages.

Georgia Kaolins. Bulletin 128 of the United States Bureau of Mines. By I. E. Sproat. This pamphlet is a valuable addition to the literature relating to the treatment of china-clay.

Standard Methods of Chemical Analysis. Edited by Wilfred W. Scott. Cloth, octavo, 860 pages. Price 30s. net. New York : Van Nostrand ; London : Crosby Lockwood & Son.

Subsidence Resulting from Mining. By L. E. Young and H. H. Stoek. Paper covers, 210 pages. Price 4s. net. This is a pamphlet published by the University of Illinois. It is devoted to a study of subsidences following coal-mining operations.

Explosives. By Arthur Marshall. Second Edition. Vol. II. London : J. & A. Churchill. The two volumes £3. 3s. 0d. We have received the second volume of new edition of this work, the first volume of which we reviewed in our April issue. In the second volume we find the chapter on ignition and detonation largely increased, and new chapters on naval and military explosives, and on commercial high explosives.

Flotation. By T. A. Rickard and O. C. Ralston. Price 12s. 6d. net. This work supersedes Mr. Rickards' book on flotation published last year. His co-author is well known as a foremost American investigator of flotation problems. The book is issued by the *Mining and Scientific Press*, San Francisco ; *The Mining Magazine* is London agent.

Tube-Milling. By Algernon Del Mar. Price 8s. 6d. net. Published by the McGraw-Hill Book Co., New York.

Timber Framing. By H. D. Dewell. Price 8s. 6d. net. Published by the *Mining and Scientific Press*. This book deals with surface structures, not to underground timbering. It will prove serviceable to all mining men.

COMPANY REPORTS

Burma Corporation.—This company was formed in 1913 to acquire control of the Burma Mines, Limited, and to further finance the business. On several occasions we have given details of the great Bawdwin lead-zinc-silver ore deposit, notably in our issues of May and June 1914, January 1915, and March 1916. The report for 1916 shows that 28,055 tons of rich ore averaging 44·2% lead, 22·5% zinc, and 41·4 oz. silver, was sent to the smelter at Namtu, as compared with 7,970 tons in 1915 ; previously the smelter had been treating chiefly the rich lead slags left behind by former workers, but this material was exhausted at the end of the first quarter of 1916. The output of lead from lead and old slags was 14,233 tons containing 977,12d oz. silver. The blast-furnace slags produced averaged 15·9% zinc oxide. The shipments during the year were 11,059 tons of refined lead, 1,987 tons of lead bullion rich in silver, and other smaller products. A silver refinery has since been added. Development has been continued and the reserve increased by over 50%, the proved ore standing at 3,223,000 tons averaging 27·7% lead, 20·6% zinc, 0·5% copper, and 25·6 oz. silver. Since the end of the year the Tiger tunnel, an adit 6,262 ft. long tapping the present lowest level, No. 6, has been completed. The ventilation and drainage problems are thereby solved, and the extraction of ore greatly improved. Tests for separating the sulphides are being continued, and reference is made elsewhere in this issue. The accounts of Burma Mines show credits of £524,929, and costs £411,901.

Consolidated Gold Fields of New Zealand.—This company was formed in 1896 by the Exploration Company to acquire from David Ziman a number of properties in the Reefton district on the west side of the south island of New Zealand. The control passed from the Exploration Co. in 1903. L. Ehrlich and E. T. McCarthy are now members of the board. The company operates the Wealth of Nations mine, and holds controlling interests in the Progress and Blackwater companies, which operate mines of those names. The report for 1916 shows that 24,186 tons of ore was treated at the Wealth of Nations, for a yield of gold worth £38,909. The working profit was £3,717 ; in addition £9,132 was received from holdings in the Blackwater company ; on the other side, £9,219 was written off for development and depreciation. The balance of profit was carried forward. The reserve is estimated at 32,149 tons averaging 8·29 dwt., a fall of 4,687 tons and 2·94 dwt. as compared with the figures a year previously. Development has been distinctly disappointing throughout the year.—**Progress Mines.** This company was formed in 1896 as a subsidiary of the Consolidated Gold Fields of New Zealand, and for 10 years dividends were paid. The report for 1916 shows that 26,780 tons of ore was treated for a yield of gold worth £29,502. Though the company received £8,629 from its holding in the Blackwater, the results for the year show a loss of £1,784. The ore reserve is estimated at 80,000 tons, but owing to the necessity for close filling no figure can be given for the average assay-value.—**Blackwater Mines.** This company was formed in 1906, and proprietary shares are held by the Consolidated Gold Fields of New Zealand and the Progress Mines. The report for 1916 shows that 40,247 tons of ore was treated for a yield of gold worth £81,755. The balance of profit was £12,212, and £12,499 was distributed as dividends, being at the rate of 5%. The ore reserve is estimated at 82,704 tons averaging 11 dwt. Development has been hindered by shortage of labour.

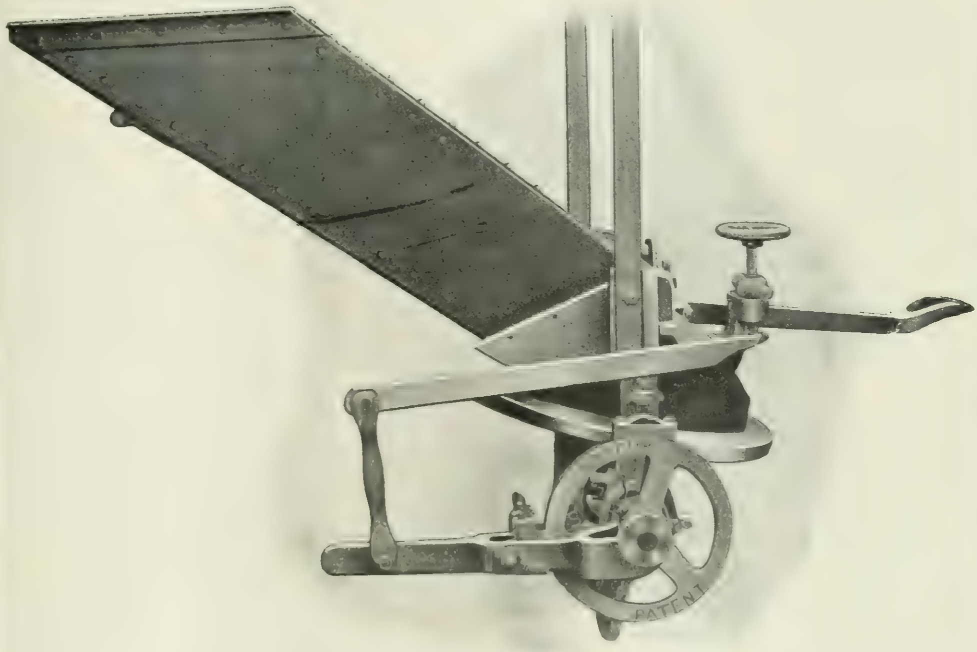
Poderosa.—This company was formed in 1908 to acquire from local owners a group of copper mines at Collahuasi, in Chile, not far from the main line of the Antofagasta and Bolivia Railway. The mines were described by Robert Hawxhurst in our issue of October 1910, and we have referred on several occasions to the various vicissitudes of the English company. With copper at a high price, profits are now being made, and, for the first time since the inadvisable distribution was made shortly after the formation of the company, it has been possible to pay dividends, 10% being distributed for 1916. The report for that year shows that the new ore-shoot in the San Carlos mine discovered nearly two years ago has proved to be of considerable importance, and is supplying nearly all the high grade shipping ore. The amount of shipping ore obtained from the Poderosa and San Carlos mines was 3,437 tons averaging 25·2% copper. At the concentration plant, 4,726 tons, partly from the mines and partly from the dumps, and averaging 6·8%, yielded 550 tons of concentrate, averaging 32·9%. In addition there was produced at the Rosario mine 666 tons averaging 31·1%, and 94 tons from the dumps averaging 22·6%. The total shipping product was 4,747 tons averaging 26·8%, and the amount shipped was 3,948 tons averaging 28·73% copper, realizing £116,302. The ore also contains silver, the average content of the ore sold being 9·41 oz. per ton. The net profit was £67,698, out of which £50,000 has been distributed as dividend, being at the rate of 10%. As regards future prospects, there is sufficient ore proved in the San Carlos shoot to last throughout the year 1917, together with reserves of concentrating ore, 10,000 tons averaging 8%, and also 1,000 tons of ore averaging 22% in the Rosario that will be extracted this year. Anything beyond this depends on the results of further development. W. J. Barnett is a director, and J. H. Ivey is manager.

Oroville Dredging.—This company was formed in London in 1909 to acquire a majority of the shares of an American company of similar name which controls certain gold-dredging operations in California. In the same year an English company, the Pato Mines, was formed to acquire gold-gravel ground in Colombia, the working capital for which was provided by the American Oroville company. Another subsidiary, the Nechi Mines, was formed in 1914 to acquire dredging property adjoining that of the Pato. The report of the English Oroville company now issued covers the year ended September 30, and with it are published the accounts of the American Oroville company for the 14 months ended September 30. During the 14 months, 3,164,136 cubic yards was treated for a yield worth $242,467, or 7·65 cents per yard. After deducting operating cost $134,334, administration expenses $16,611, and allowance for final depreciation of dredges on their dismantling, $23,332, and crediting the accounts with $89,067, the interest on money advanced to the Pato company, and other smaller items, a net profit of $180,029 remained. This being added to the balance brought in, $470,315, made a disposable surplus of $650,344, out of which $436,210 has been distributed as dividends. The accounts of the English company show receipts of £72,127 from dividends paid by the American company. Out of this, £68,653 has been distributed as dividends, being at the rate of 10%. —**Pato Mines (Colombia).** The report for the year ended September 30 shows that 1,484,721 cubic yards of ground was dredged for a yield of gold worth £148,043, or 8s. 1d. per yard. The net profit was £74,657.—**Nechi Mines (Colombia).** The report for the 15 months ended September 30 shows that 1,617,975 yards was dredged for a yield of gold worth £165,669, being 8s. 4d. per yard. The net profit was £78,845, out of which £17,500 has been paid as preference dividend, being at the rate of 25%. W. A. Pritchard is manager of the Pato and Nechi mines.

Ropp Tin.—This company was formed in 1911 to acquire alluvial tin properties south of Bukeru, Northern Nigeria. Edmund Davis is chairman, and the technical staff of the Consolidated Gold Fields of South Africa are the consulting engineers. The tin concentrate so far won has been obtained by calabashing, but within a short time the first of the two bucket-dredges will be at work. The testing of the ground for these dredges was done by W. E. Thorne, and the supervision of their erection has been in the hands of C. J. Inder. The report for the year 1916 shows that 467 tons of concentrate was produced, as compared with 394 tons in 1915, and that 426 tons was shipped. The accounts show receipts of £55,352 and a net profit of £15,568, out of which £11,250 has been paid as dividend, being at the rate of 25%. The share capital is £45,000, there are £53,980 debentures, and a loan of £16,000, to be exchanged into debentures whenever Treasury permission is granted. John Daniell, the manager, reports that the proved gravel in the dredging ground contains 10,917 tons of black tin, and that other areas contain 1,309 tons.

Chenderiang Tin Dredging.—This company belongs to the F.M.S. Timah group, and was formed in 1914, as a consolidation of the Chenderiang Valley and Jabus companies, to operate alluvial tin ground in Perak, Federated Malay States. The report for the year ended March 31 last shows that the Chenderiang dredge treated 1,110,000 cubic yards for an output of 260 tons of tin concentrate, being a yield of 0·53 lb. per yard. The working cost per yard was 3·56d. including local administration, but not London expenses or depreciation. In the Jabus area, where hydraulic elevating is practised, the output was 67½ tons. The income from the sale of concentrate was £33,370, and the net profit was £5,382. A dividend of 5% has been paid, absorbing £4,625.

Rezende Mines. — This company was originally formed in 1892 as the United Gold Fields of Manica, for the purpose of working a gold-mining property near Umtali, Rhodesia, not far from the boundary of Portuguese East Africa. The results were generally disappointing, and several reconstructions were necessary. In 1908 the control passed to the Anglo-French-Farrar group, and in 1913 to Farrar Brothers. In 1912 the Penhalonga company's property adjoining was absorbed. After helping the company to pay dividends for four years, the Penhalonga property became exhausted, and operations are now confined to the Central and Old West workings. The report for 1916 shows that 103,443 tons of ore was raised, of which 56,810 tons averaging 5·95 dwt. came from the Central, and 46,633 tons averaging 2·25 dwt. from the Old West mines. The yield of gold at the Central was worth £65,581, or 23s. 2d. per ton, and the working profit £910; the yield at Old West was £18,461, or 6s. 11d. per ton, and the working loss £1,226. After allowance had been made for administration, depreciation, and income tax, the loss for the year was £9,371. S. R. Jameson, the manager, writes more hopefully for the current year. Though the assay-value of the Central ore continues to diminish, other supplies of ore have been found in the Eastern section, the extent of which is not yet, however, known. The reserve in the Central section is figured at 78,491 tons averaging 6·6 dwt., and at the Old West 272,316 tons averaging 3 dwt.



The "Hoscur" Feeder

MODERN Stamp Mills designed for continuous heavy duty should instal the "Hoscur" Feeders. The "Hoscur" is a practical, improved Feeder of the Challenge type, invented by a Mining Mechanical Engineer of many years' experience. It is simple and effective, assuring regularity and continuity of feed and requires no attendance.

The "Hoscur" Improvement is easily and cheaply applied to any existing Feeder.

WRITE FOR BULLETIN

SANDYCROFT Ltd.

CHESTER, *and* 9 QUEEN ST. PLACE, **LONDON**
E.C.4

OROVILLE DREDGING COMPANY, LIMITED.

Directors: F. W. Baker *(Chairman)*, F. D. Behrend, H. C. Porter, A. S. Elmore, T. J. Hoover, Lord Brabourne. *Secretary:* Henry Richards. *Office:* 441 Salisbury House, London, E.C.2. *Formed* 1909. *Capital* issued: £686,538 in £1 shares.

Business: Holds the majority of the shares in an American company of similar name controlling gold-dredging operations in California; has controlling interests in the Pato Mines and Nechi Mines, two companies operating gold dredges in Colombia.

THE sixth ordinary general meeting was held on July 16 at Salisbury House, London, E.C., Mr. Frederick W. Baker (the Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended September 30 last, said during the year the American Oroville Company paid four quarterly dividends of 12½ cents per share, amounting to £72,127 which, together with other credits shown in the profit and loss account, brought the revenue to £76,356 and, after debiting all charges in London for the year, the balance to credit of profit and loss account carried to the balance sheet was £72,962. Adding to this amount the balance to the credit of profit and loss account brought forward from the previous year of £14,385, a total of £87,347 was shown. Deducting from this the four dividends of 6d. per share paid in December 1915, March, June, and September 1916, amounting to £68,653, a balance of £18,693 remained to the credit of the profit and loss account as at September 30 last. The accounts of Oroville Dredging, Ltd., the American company, showed that the operating profit of that company for the fourteen months to September 30, 1916, including $91,262·92 interest on Pato Mines (Colombia), Ltd., Eight Per Cent. Income notes and discount on income notes redeemed, amounted to $208,993·63, leaving, after deducting administration expenses, mine and depreciation charges, a balance of $180,029·55. After deducting from this amount and that company's available surplus the five dividends of 12½ cents per share there remained available to the credit of profit and loss as at September 30, 1916, the sum of $214,134·70.

The manager's report from Oroville showed that the returns from 3,164,136 cubic yards excavated averaged 7·65 cents per cubic yard, with a net revenue of 3·75 cents as compared with 2,569,643 cubic yards treated, averaging 8·89 cents, and giving a net revenue of 4·44 cents respectively for the previous twelve months. At the Pato mines, in his annual report of field operations to September 30, 1916, the general manager, Mr. W. A. Prichard, stated that 1,484,721 cubic yards were dredged, as compared with 1,308,470 cubic yards for the previous year, the gross value of the gold recovered being $719,483, averaging 48·5 cents per cubic yard, as against $618,883·88, averaging 47·3 cents for the previous year. Notwithstanding the abnormal cost of dredge repairs and the heavy increase in operating expenses by war prices for materials and freights, the field operating cost for the year averaged only 12·46 cents per cubic yard, as compared with 11·4 cents for the previous year, and after taking credit for the Nechi Company's proportion of management expenses and rental for the use of plant and machinery and debiting the amounts allocated for depreciation and upkeep of plant and machinery, as detailed in the Pato accounts, the operating cost on this property for the year under review was reduced to 12·13 cents per cubic yard. The Nechi dredge commenced operations on September 1, 1915. Mr. Prichard, in his annual report to the Nechi Company's board, pointed out that in consequence of the suspension of operations at various times, owing mainly to the necessity for alterations in the construction of the dredge and the erection of new bucket plant and a shortage of water power for a certain period during the dry season, the Nechi dredge was employed for only 58% of the possible running time during the thirteen months to September 30, 1916. In that period 1,617,975 cubic yards were dredged, the gross value of gold recovered being $651,068, averaging 49·27 cents per cubic yard, with an average depth dredged of 51·9 ft.; the field costs averaged 9 cents per cubic yard, including 5 cents for dredge repairs, which Mr. Prichard stated under normal conditions could be considerably reduced. With the addition of £1,000 per month rental to the Pato Company for the use of their power plant and the proportion of management expenses charged to the Nechi account in the London books, plus depreciation, the field costs for the period were increased to an average of 15·20 cents per cubic yard. The result of work carried out during the current year had confirmed the high value of the gravels on the Nechi property, and while the results obtained during this current year would not exceed materially the results for the period under review, he could state with the greatest assurance that, were it not for war conditions and the excess profits situation, they could earn from this property in any year, until they had exhausted the high-grade ground, an amount equal to approximately twice the earnings for the period ended September 30, 1916, and probably at a very large reduction in operating cost.

The Nechi Company was in an unfortunate position as regards excess profits duty. Unfortunately they had no pre-war standard, and they were therefore assessable for excess profits after such allowances as the Revenue authorities or the Board of Referees might be willing to give at the rate of 60% assessment on the earnings for 1915-16, at the same rate for this year, and at the rate of 80% for 1917-18. In his judgment it certainly would be a reflection on the good sense of the Treasury authorities if they should show the company no special consideration in respect of this form of taxation. This company, as now equipped, could earn approximately an income of over £200,000 a year until the richer gravels were worked out. The question was whether shareholders would authorize the board to work the property at its full capacity in the richer ground and pay from 60 to 80% of the earnings away in the form of excess profits tax. The board felt disposed to recommend that, unless they got some reasonable and fair treatment from the Revenue authorities, their clear duty was to suggest that the dredge be put to work on the poorer gravels until the relief from inordinate and excessive taxation would enable them to work out the richer gravels.

Other properties had been examined, and two were being tested, one in Colombia, and one in California.

Mr. H. C. Porter seconded the motion, and it was carried unanimously.

NECHI MINES (COLOMBIA), LIMITED.

Directors: F. W. Baker (*Chairman*), F. D. Behrend, A. S. Elmore, T. J. Hoover, H. C. Porter. *Secretary:* Henry Richards. *Office:* 441 Salisbury House, London, E.C.2. *Manager:* W. A. Prichard. *Formed* 1914.
Capital: £140,000 divided into 140,000 25% preference shares of 10s. and 140,000 ordinary shares of 10s.

Business: Is a subsidiary of the Oroville Dredging Co., Ltd., and works an alluvial gold property by bucket-dredge in Colombia.

THE second ordinary general meeting was held on July 18 at Salisbury House, London, E.C., Mr. Frederick W. Baker (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended September 30 last, said that the balance sheet showed that the whole of the capital on the 140,000 25% preference shares of 10s. each had been called up, and that the 140,000 fully-paid ordinary shares of 10s. each, forming part of the consideration payable for the property, had been issued, and the balance of the £20,000 in cash, part of the consideration, had been paid. The profit and loss account showed that the net receipts, including gold returns, amounted to £164,240. 14s. 7d. After debiting field costs, £44,519. 17s. 4d., provision for income tax, £23,052. 19s., depreciation written off capital expenditure, £6,110. 2s. 7d., balance of preliminary expenses, £8,000, and all London administration expenses, the credit carried to the balance sheet was £78,845. 6s. 1d. Deducting from this the debit brought forward from the previous year, £2,749. 17s. 11d., and the dividend of 2s. 6d. per share paid in reduction of the preference share indebtedness, the balance carried forward was £58,595. 8s. 2d. From this two further dividends of 2s. 6d. each had been paid on the 25% preference shares, namely, in October 1916, and April 1917, making a total of 7s. 6d. per share on the preference shares, and but for the uncertainty as to the excess profits tax, they would have paid the final instalment of 2s. 6d., and redeemed the entire preference capital.

Mr. Prichard's report indicated that the Nechi dredge commenced operation on September 1, 1915. In consequence of the suspension of operations at various times, mainly owing to the necessity for alterations in construction of the dredge, and the erection of a new bucket plant owing to certain defects in material furnished when the dredge was constructed (which developed after the dredge had started operation), and necessitated the ordering of a new bucket line, also to a shortage of water power for a certain period, due to the abnormally dry season, making it impossible to run both Nechi and Pato dredges concurrently, the Nechi dredge was employed for only 58% of its possible running time during the thirteen months to September 30, 1916. In addition to the reasons above given, the management decided that it would be prudent to operate the Nechi dredge in its early stages of operation along the banks of the river, so as to create a wall under which the dredge could shelter for protection against heavy floods during the rainy season, and it was thought advisable for rapidity in work not to operate the dredge at its greatest operating depth, so that while that work was being done they got a much lower average per cubic yard than would have been the case had they gone to bedrock, and to this fact might be largely attributed the average of only 49·27 cents per cubic yard, while the operating costs had been affected by the fact that they were only working 58% of the normal running time. This had not been altogether a misfortune, in view of the uncertainty as to how they might be assessed for excess profits. For some of the weekly returns had clearly confirmed that in proved areas which would be touched, they could look for very much higher values than the average for the year under review, which certainly looked like confirming Mr. Prichard's estimates of high-grade gravels in their proved areas. They had instructed the manager not to touch the high-grade areas more than absolutely necessary until they knew how they stood on the excess profits question.

In the period under review the Nechi dredge treated 1,617,975 cubic yards, the gross value of gold recovered being £651,068, averaging 49·27 cents per cubic yard, with an average depth dredged of 51·9 ft. The field-cost averaged 9 cents per cubic yard, including 5 cents for dredge repairs, which, Mr. Prichard stated, under normal conditions would be considerably reduced. With the addition of £1,000 per month for rental to the Pato Co. for the use of their power plant, and the proportion of management expenses charged to the Nechi accounts in the London books, plus depreciation, the field costs for the period were increased to an average of 15·20 cents per cubic yard. The year's operation had also disclosed another interesting fact, namely, that, owing to the looseness and fineness of the gravel, the dredge could handle, operating at full capacity, practically twice the yardage upon which the original calculations were based; so that they could, if they were working under normal conditions, work out the property in about half the life originally estimated. There was no question that the earnings, no matter what amounts they might be under obligations to pay in respect of excess profits, should be sufficient, after they had redeemed the last instalment of the preference indebtedness, which he hoped would be soon, to cover the interest on preference shares. As the whole of the ordinary shares were in the hands of the Oroville and Pato Companies, the question of what policy was to be pursued in operating the property, to yield an amount in excess of the preference dividend obligation, was one which remained with the Oroville Co. as controlling owners. Shareholders in the Oroville had authorized the board at the meeting of that company to carry out a policy which should not militate against an earning sufficient to meet the interest due on the preference shares, so that their rights would in no way be prejudiced by the conclusions arrived at.

In addition to the usual construction work, the Pato company had carried out an important addition to the height of the dam, so as to ensure greater storage of water, with the idea of obviating in the future any stoppage of operations, such as they had had this year, owing to an abnormally dry season. Mr. Prichard had made such changes in the management of the mine in all departments that they were securing very effective co-operation and work from the staff, with the result that things were now in such a shape that Mr. Prichard could leave the property at any time with the complete confidence that operations would proceed in a satisfactory and normal way.

Mr. A. S. Elmore seconded the resolution, which was carried unanimously.

HENDERSON'S TRANSVAAL ESTATES, LIMITED.

Directors : Lord Oranmore and Browne *(Chairman)*, R. De La Bere, Sir Ernest F. G. Hatch, W. E. Lawson Johnston, H. G. Latilla, Edmund Nuttall, W. L. Castleden *(Managing Director)*. *General Manager in South Africa :* William Pott. *Secretary :* F. R. Cunningham. *Office :* Egypt House, New Broad Street, London, E.C. *Formed* 1894 ; reconstructed 1912. *Capital* issued : £686,570 in shares of 5s. each.

Business : The development of mining and other property in the Transvaal and other parts of South Africa. Has a large interest in the Daggafontein gold property and in various collieries in the Transvaal.

THE fifth ordinary general meeting was held on July 20 at River Plate House, Finsbury Circus, London, E.C., the Rt. Hon. Lord Oranmore and Browne (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31, first went in detail through the accounts, and then proceeded to give information relative to the various holdings. The Tweefontein Colliery Co. had again distributed dividends of 25% on the ordinary shares and 10% on the preference shares, and they anticipated continued and increasing prosperity in the coal trade of the Transvaal, provided an adequate supply of railway rolling stock was available to meet the increased trade. As shareholders were informed in the report, the development of the Tweefontein No. 236 (No. 1 Area), a promising coal property, had been proceeded with and, as mentioned in the report, they hoped to be in a position to supply coal under the contract with the South African Railways within the next two months. The bulk of the coal trade of the Transvaal was controlled by the Transvaal Coal Owners' Association, which was a combination of the principal collieries. The combine at present in existence expired on June 30, 1918, and the new combination would be for a period of five years. He was not certain whether all the terms of the new agreement for the period commencing July 1, 1918, had been settled, but he knew that the clause determining the outputs to be allocated to each company comprising the association had been arranged. Under the agreement the Henderson Consolidated Corporation (the owner of Tweefontein No. 236) had been admitted to membership, and was assured of a satisfactory monthly output from July 1, 1918. The payment of a first dividend of 12½% by the Cement Company had fully justified the high opinion formed as to the prospects of the enterprise. The success of the company was assured, and with the return of normal times in South Africa the undertaking would participate in the general prosperity. Those interested with them in this business were the leaders in the cement industry in the Empire, and the company therefore benefited from the expert knowledge. The opening up of the Daggafontein property had been very fully dealt with in the report. The most encouraging development had been in the west haulage. This part of the mine lay in the direction of the Springs Mines, which had now reached the producing stage. The profits of the Delagoa Bay Development Corporation which came into the year under review, while showing some improvement as compared with the previous year, did not justify a distribution to its shareholders. The corporation had suffered through the war more than any other with which the company was associated, the principal reason being the low rate of Portuguese exchange. The report recommended the payment of a dividend at the rate of 5% less income tax. The amount required for that purpose would be about £34,328, as against £31,752 last year. He told shareholders last year that he should not advocate the payment of a dividend unless he saw his way to continue it in the future, and in view of the fact that they were this year carrying forward nearly £50,000, and of the progress which was being and had been made in various concerns in which they were interested, he felt amply justified in proposing the distribution.

Mr. W. L. Castleden, the Managing Director, seconded the resolution. He said that as the affairs of the company had been dealt with in detail in the Chairman's speech he did not propose to inflict a long speech upon them, but before formally seconding the adoption of the report and accounts he would like to say a few words as to the future prospects of the company. The views he was going to express were entirely personal, and based upon careful consideration of the company's affairs generally. In his opinion, the company was now well on the way to success. He did not wish them to infer that by success he meant dividends at a very high rate in the immediate future, because such was not the case. By success he meant steady progress in the development of the valuable interests which the company undoubtedly held, so that eventually the company would receive from its varied assets an annual revenue which would enable it to maintain its present strong financial position and at the same time distribute an increasing dividend to its shareholders. The most important thing, to his mind, at the present time was the maintenance of a strong financial position, for unless they did this they could not fully avail themselves of the opportunities which they foresaw for increasing their revenue. The asset which at the moment appeared to promise the quickest return was coal, and here there seemed every prospect of developing what was, in his opinion, a most profitable enterprise with a minimum of risk. Coal was a commodity which was universally required and had this advantage over gold, that gold had a fixed value, while the value of coal was fixed by the demand. Now, the demand for coal in South Africa had increased enormously of recent years. He would admit that this was to a certain extent due to the war, but the demand had normally increased prior to the war, and he saw no reason why it should not continue to expand after peace had been made. Their first coal venture, the Tweefontein Colliery, had proved an unqualified success, and they had now equipped another mine adjoining Tweefontein on the same property, and there was every reason to anticipate equally good results from the new mine eventually. He said eventually, as a mine did not enter the profit-earning stage directly it began to produce, as their experience with Tweefontein showed, but he had no doubt as to the satisfactory result of the new venture within a comparatively short time, and he firmly believed they would from this source alone be in receipt of an annual return which would be the first step toward what he had previously referred to as success.

The resolution was carried unanimously.

SOUTHERN SHAN STATES SYNDICATE (1909), LD.

Directors : F. D. Holroyd (*Chairman*), H. Greenwood, H. W. Hewitt, E. L. Reynolds. *Secretary :* J. A. Henderson. *Office :* 18 St. Swithin's Lane, London, E.C.4. *Formed* 1909. *Capital* issued : £129,330 ; debentures issued £24,140.

Business : Was formed to acquire certain prospecting licences in Burma ; as a result of developments, floated the Mawchi Mines Ltd., the shares in which are now its chief asset.

THE adjourned annual general meeting was held on July 18 at the Cannon Street Hotel, London, E.C., Mr. F. D. Holroyd (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that the investment in Mawchi shares was unchanged, with the exception that the final call had now been paid, and that investment stood at the figure of £124,634. 4s., as shown in the balance sheet. Their investment in the General Petroleum Company, which last year stood in the form of first mortgage bonds, had been converted into common stock at par, together with an additional 2,400 dollars, representing the accrued interest for the two years ended November 1, 1915. This was done under the re-organization scheme of that company. The Mawchi loan account, which at the last meeting stood at over £13,000, had since been reduced to £1,394 1s. 6d. The Mawchi concentrate account represented the amount due to them at the date of the balance sheet at the rate of £18 per ton under the arrangement referred to in the report. By this arrangement, instead of dealing with 1,256 tons of Mawchi concentrates under their contract they agreed to allow the Mawchi Company to deal with these concentrates themselves on the basis that they should pay them £18 per ton up to the total of 1,256 tons. Since the date at which the balance sheet was made up a considerable sum had become due to them under this head, and they had received various amounts from the Mawchi Company in respect thereof. At the present time the Mawchi owed them approximately £3,345 under this contract. Shareholders would be pleased to know how advantageous it had been not only for this company but also for the Mawchi Company (in which they held 61% of the issued share capital), that they prevented this contract going into outside hands, and retained the benefit of it for this company, and they were greatly indebted to Mr. Adamson for the advice that he gave in May 1915, upon which they prevented the old Mawchi board from placing this contract elsewhere and succeeded in obtaining it for the syndicate. During the year 1916 they succeeded in still further reducing the outstanding items on loan account, and they anticipated that the balance now remaining, shown as £1,311. 14s. (which was principally represented by a deceased's estate), would eventually be realized without loss to the company, as the security they held in connection with that estate consisted of shares in a colliery company which had already paid several dividends, and had thereby considerably improved in value. The assets in Burma were sundry items of mine implements and analytical instruments remaining on their hands after they closed down the exploration work at Kalaw. They offered these to the Mawchi Company, but as they were not suitable for its work they were at present stored at Mawchi until a convenient opportunity offered itself for realization. With regard to the commission account of £10,000, which was the same figure as appeared in the last balance sheet, this was the commission (in shares only) paid to the H.W.G. Syndicate, Ltd., as to 5,000 shares for subscribing £10,000 debentures of their syndicate and as to the remaining 5,000 shares for guaranteeing an overdraft from the bankers to an amount of £10,000. The monetary value of these shares at the time they were issued was roughly £1,700 in all. Eventually, of course, this item would have to be written off, but they did not propose to deal with any portion of it in the balance sheet now submitted.

As regards the profit and loss account, the item of expenditure in Burma represented the small balance of wages and sundries incurred in connection with closing down the company's exploration work at Kalaw, and since the date of the balance sheet they had incurred no fresh expenditure in Burma. During the year they made nearly £8,200 in connection with the Mawchi concentrate contract, and this was their principal source of revenue until such time as the Mawchi shares began to pay dividends, which they hoped was not far distant. The net balance of profit after paying charges was £5,672, and deducting from this the debenture interest for the year, left them with a net profit of £3,975, which was applied in reduction of the loss brought forward from the previous year, and left £21,222 net loss brought forward from the old accounts. This represented the balance of the amount written off in respect of the costs of the Salween license, and they would have to write this off over a term of years.

On March 30 last Mr. Adamson resigned his seat on the board, and he had also resigned from the board of the Mawchi Company, and had been appointed technical manager to that company as from April 1, 1917. They proposed to submit a resolution to pay one-third of the sum of £1,000 which it was proposed by the Mawchi Company should be paid to him for his extra services. Mr. Hamlyn's seat on the board was vacated on April 20 last by the unanimous request of his co-directors. They recommended that these vacancies should not be filled. Notice had been given to submit the names of four gentlemen as directors of the company. The board did not approve of this suggestion, as they considered it would not in any way conduce to the effective and quiet management of their affairs. Mr. Greenwood retired by rotation, and had offered himself for re-election. He would complete the number suggested under the scheme of reconstitution.

The Chairman proceeded at some length to circumstances connected with the difference of opinion between Messrs. Hamlyn and Bruce Dick and the board. These two shareholders replied, giving their view of matters. On the resolution to adopt the report and accounts being put to the meeting it was carried by show of hands. A poll was then demanded.

At the adjourned meeting held on August 8, at the Cannon Street Hotel, E.C., the Chairman (Mr. F. D. Holroyd) announced the result of the poll demanded at the meeting held on July 18, which showed a majority of 7,170 in favour of the policy of the directors on all the resolutions submitted.

MAWCHI MINES, LIMITED.

F. Holroyd (*Chairman*), C. K. Everett, H. Greenwood, H. W. Hewitt, E. W. Janson, E. L. Reynolds, Lt.-Col. P. Wigham Richardson. *Secretary:* J. A. Henderson. *Office:* 18 St. Swithin's Lane, London, E.C.4. *Formed* 1914, as a reconstruction of the Mawchi Tin and Wolfram Mines Ltd. formed in 1911. *Capital* issued : £221,065 ; debentures £27,390.

Business: Operates the Mawchi tin and wolfram mine, in the Southern Shan States, Burma.

THE adjourned annual general meeting was held on July 18 at the Cannon Street Hotel, London, E.C., Mr. F. Holroyd (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, 1916, said that the debenture debt had been reduced from £33,930, at which it stood in the last balance sheet, to £27,390 by purchase and redemption. Since the balance sheet was struck a further £2,200 had been subscribed in cash under the new debenture scheme, which was reported to the shareholders at the last general meeting, and this £2,200 was almost entirely money re-invested by the holders of the former debentures redeemed at the last drawing. The amount now outstanding was, therefore, £29,590 out of the £50,000 new debentures which were authorized to be issued. In May 1915, a contract was made for the sale to the Southern Shan States Syndicate (1909), Ltd., of the company's output of concentrates up to a total of 1,256 tons. An arrangement had been come to whereby a sum of £18 per ton was to be paid to the syndicate in respect of each shipment of concentrates received by the company up to a total of 1,256 tons. This arrangement had enabled the directors to deal with the concentrates on behalf of the company, and had secured to the shareholders a very considerable profit. At the same time the Shan Syndicate received £18 a ton on every shipment, and therefore the arrangement was to the mutual advantage of both companies. With regard to the bank overdraft, owing to the realizations of concentrates since the balance sheet was prepared, they had discharged the whole of it, and were in credit by £9,921. 16s. 6d. The plant, machinery, etc., in Burma had been written down, and the depreciation under these heads was £4,218. This was a wise provision to make, because, in a tropical climate like Burma, plant, machinery, and buildings, etc., had all a much shorter life than they would have in a country like England. They had a balance from trading account of £11,978, and a balance of profit carried down at £4,389. 16s. 6d. Deducting from this debenture interest and debenture trustees' fees, together £2,333. 5s. 8d., gave a net profit of £2,056. 10s. 10d. to apply in reduction of the loss brought forward from the previous year, which left them with a net loss of £3,865. 11s. 8d. to extinguish. The concentrates sold since the date of the balance sheet had given a profit more than sufficient to extinguish this balance.

Some of the difficulties which the new board had to face, on taking office in August 1915, were—(1) Breakdowns owing to insufficiency of spare parts ; (2) stoppages owing to sinking of foundations and floors and cracks in walls through bad workmanship ; (3) staff difficulties owing to non-payment of salaries, etc., through want of funds ; (4) the mine was heavily in debt in Burma and had reached the limit of its credit, so that had this state of matters gone on much longer the probability was that the mine would have been entirely taken over by the Government under the powers in their lease or a reconstruction of this company would have been necessary, so as to find more cash. This position, however, was saved immediately they came into office by cabling a sum of £3,000. In order to avoid any further risks of stoppages the mine was now well supplied with all necessary spare parts ; all known defects in foundations, etc , had been put right ; the staff was efficient and working smoothly. The credit of the mine was sound in Burma, with ample funds in hand to meet any unexpected contingencies. Possibly this satisfactory position would not have been attained but for the fact that, by preventing the contract of 1,256 tons going into the hands of third parties, they had been able to re-arrange matters with the Shan Syndicate which had enabled this company to get the full benefit of the present high prices. This satisfactory position was very largely the result of the most valuable services rendered to the company by Mr. Adamson. It would be well within the recollection of most shareholders that the old board had practically completed an arrangement by which they were to sell the whole of the output of the mine at a price which would have given them for the wolfram contents of the ore only two-thirds of 30s. per unit—that is, 20s. per unit. Mr. Adamson advised that this price was ridiculously inadequate, and he advised them as directors of the Shan Syndicate to take over the value of this contract, which they did. The result was that the combined companies of Shan and Mawchi would make a profit of approximately £50,000, which but for them preventing the contract going into the hands of third parties would have been entirely lost to them. The credit for keeping the contract in the family was entirely due to Mr. Adamson. In addition to other work he was the means, through his connection in Sheffield, of getting the Sheffield Banking Company to finance the concentrates on much more favourable terms than any bank in London would think of. Shareholders would agree that he had fully earned the additional £1,000 which they proposed to ask them to ratify that day.

With regard to the future, the programme for increasing output and reducing average costs might necessitate the finding of considerable sums of money, and, providing they were allowed to carry out the programme on their own lines, the directors were willing to continue finding working capital, as they had done since their coming into office. The output was gradually creeping up, and would have been maintained but for the fact that the staff were compelled to leave the mine for a fortnight to go up for medical examination under the Conscription Act of India. This, however, was only temporary, as the British Government was asking for the exemption of all men engaged in wolfram mining. They hoped as soon as more labour could be obtained to see the output still further increased beyond the present average of about 70 tons per month. The ore reserves were 58,095 tons, and considerable further development would have to be done to enable them to decide whether it was advisable for the capacity of the present mill and machinery to be still further increased at an early date.

Mr. E. W. Janson seconded the resolution, which, after some discussion, was carried.

ANANTAPUR GOLD FIELD, LIMITED.

Directors: John Taylor (*Chairman*), Lt.-Col. Sir Donald Robertson, Vere Herbert Smith, H. C. Taylor. *Managers and Consulting Engineers:* John Taylor & Sons. *Secretary:* W. L. Bayley. *Office:* 6 Queen Street Place, London, E.C.4. *Formed* 1906. *Capital* issued: £60,000 in ordinary shares and £26,788 in preference shares.

Business: The finance and development of gold-mining properties at Anantapur, Bombay Presidency, India, Has floated the Jibutil and North Anantapur companies. Is now developing the Ramagiri Block.

THE twelfth ordinary general meeting was held on July 25 at 6 Queen Street Place, London, E.C., Mr. John Taylor, M.Inst.C.E. (the Chairman of the company), presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31, said that the total expenditure on general account amounted to £7,234, and the outlay on buildings, machinery, etc., was £897. The receipts on account of dividends, interest, rents, etc., totalled £618. Attention had been mostly directed to the exploration of the ground in the vicinity of No. 1 shaft on the Ramagiri block. At the close of the financial year on March 31 last, the company held 16,737 fully-paid ordinary shares and 827 preference shares of the North Anantapur Gold Mines, Ltd., and 5,793 fully paid ordinary shares and 535 fully-paid preference shares of the Jibutil Gold Mines, Ltd. From the North Anantapur Company they received dividends for the twelve months ended June 30, 1916, amounting to 4s. 6d. per share on the preference and 6d. per share on the ordinary shares, and an interim dividend of 2s. per share had been paid on the preference shares on account of the profits for the year ended June 30, 1917. The most important event of the year for their company was the sale of a further portion of land to the North Anantapur Gold Mines The area was half a square mile and contiguous to the original northern boundary of the North Anantapur. The purchase price agreed upon was 15,000 fully-paid ordinary shares of £1 each in the North Anantapur Gold Mines, Limited.

Lieut.-Colonel Sir Donald Robertson, K.C.S.I., seconded the motion.

Mr. Henry C. Taylor said that the mining property held by the company under prospecting licenses was last year stated to cover an area of 6½ square miles. Of this, half a square mile had now been disposed of to the North Anantapur Gold Mines, Ltd. The land in question formed part of the North Buruju block, and had been prospected at shallow depths. No discovery of importance resulted, though two distinct reefs were found running through the ground. During the past year their company had continued work at No. 1 south shaft on the Ramagiri block. At this place there were three reefs, which had been explored to a depth of 300 ft. The main reef at this depth had been proved for 181 ft. in length to have an average width of 5½ ft. and a value of 4 dwt. of gold per ton. In places the quartz widened out to 10 ft. or more, and this also occurred on the eastern reef, where a short shoot of ore of fair grade had been opened up. Recently prospecting work had been commenced at a place 450 ft. south-west of No. 1 shaft. The old workings here had been cleared to a depth of 128 ft. It was found that a width of no less than 15 ft. had been worked by the ancients. Within this width quite a number of parallel branches of quartz occurred and several rich pannings of free gold had been obtained from the quartz left standing. It was too early yet to say much about this discovery, but it certainly seemed likely that some payable ore would be opened up.

The resolution was unanimously adopted.

PODEROSA MINING COMPANY, LIMITED.

Directors: Charles Fearn (*Chairman*), W. J. Barnett, V. Echeverria, Lionel W. Harris. *General Manager:* J. H. Ivey. *Secretary:* F. W. Bishop. *Office:* Dashwood House, London, E.C.2. *Formed* 1908. *Capital:* £500,000 in 100,000 shares of £5 each.

Business: Operates copper mines at Collahuasi, Chile.

THE eighth annual general meeting was held on July 17 at Winchester House, London, E.C., Mr. Charles Fearn (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that the cash position at December 31 last showed a free balance, inclusive of readily realizable investments, of about £90,000, after providing for unpaid dividends. This figure had since been largely increased. The net proceeds from sales of ore were £116,302, being slightly more than double the figures of 1915, the principal cause of the increase being the high price of copper ruling during the year. They were fortunate in arranging a new contract with smelters in the United States, which came into force in the latter half of the year under review, and the terms of which were more favourable than could be obtained in this country. The production for the year showed a slight increase over the previous year both in quantity and grade, mainly due to the discovery of the shoot of rich ore between the 6th and 7th levels of the Poderosa, San Carlos section. This had now been proved from the 4th to the 7th levels, and it was hoped would be found to extend deeper still. The production from the Rosario mine also showed an increase on the previous year, while the output from the concentration plant was maintained, with a slightly higher assay-value. As regards the future, a satisfactory output for the current year was assured, but beyond this the future depended chiefly on developments in depth in the Poderosa, San Carlos, and in the Rosario. Meantime exploration work was being pushed ahead. The estimated profits for the first half of the current year exceeded those of the whole of last year. But the board had declared an interim dividend for 1917 of only 2s. 6d. per share, as compared with 5s. for the past year, for two reasons. One was that in declaring 5s. in December 1916 they had practically completed the year and the profits were assured, while in the case of the current year's working only half the year had gone. The other reason lay in the excess profits duty. As a result of his (the Chairman's) visit to South America the company had obtained on favourable terms a controlling interest in a tin property in the Potosi district of Bolivia. Work on a limited scale was now being carried out on the property.

Mr. Lionel W. Harris seconded the motion, which was carried unanimously.

BURMA CORPORATION, LIMITED.

Directors: Sir Trevredyn R. Wynne (*Chairman*), Sir Hugh Barnes, R. Gilman Brown, F. A. Govett, H. C. Hoover (alternate John A. Agnew), Walter McDermott, S. C. Magennis, R. Tilden Smith. *Consulting Engineer:* A. F. Kuehn. *Secretary:* D. Anderson. *Office:* 1 London Wall Buildings, London, E.C.2. *Formed* 1913. *Capital:* £899,547; in 821,079 £1 shares fully paid and 142,670 £1 shares 11s. paid; debentures £14,410.

Business: Controls the Burma Mines, Limited, which operates the Bawdwin lead-zinc-silver mine in Burma.

THE annual general meeting was held on August 1 at River Plate House, Finsbury Circus, London, E.C., Sir Trevredyn R. Wynne (Chairman of the corporation) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that they were able this year to present a profit and loss account, and after writing off the whole of the expenditure to the end of 1916 they were able to carry forward the sum of £39,266. The ore reserves in the Chinaman ore-body on January 1, 1917, had been increased by almost 60%, the proved ore being 89% of the total, as against 76% for the previous year. From a telegram just received, the ore reserves at the end of June this year were estimated as 3,793,000 tons, of which only 9¼% was probable, the remaining 90¾% being proved ore. The increase in the ore reserves in the Chinaman ore-body to date, as compared with the tonnage at the end of 1915, was thus 65%. The Tiger tunnel had been completed double track width to the internal shaft, a length of 7,333 ft. and was now being pushed on to the vertical shaft, a further 1,500 ft., of which 744 ft. had been completed up to July 26 this year. The output of lead had been won largely from first grade lead ore, as against rich slags during the previous period. This had called for the local manufacture and installation of a very large amount of smelter equipment. The production of silver was about three-and-a-half that of the previous period, and at the present time one month's silver production almost equalled the entire 1915 production, when slags with small silver contents were smelted. The production of refined lead was 60% greater, and the refinery capacity should shortly be able to convert into refined lead, refined silver, and the by-products, copper and antimony, the entire work lead or hard lead production, which for the past six months averaged about 1,600 tons per month. The silver refinery had been in operation since December last, and its output was gradually on the increase. During the month of June 1917, the production was 60% of the silver in the output of work lead. The silver refinery should from now on produce 100,000 to 125,000 oz. monthly. The refined silver was 996 to 998 fine, and was marketed in India. It was obvious that the present production of lead and silver was governed by the exigencies of war, which hampered operations by shortage of stores and supplies, but the lead and silver production position was distinctly sound for the future.

Owing to the shortage of staff for part of the period to the necessity of manufacturing much equipment which under normal conditions was imported, and to the necessity of using the milling plant for smelter crushing purposes until the new crushing plant was completed, large scale ore testing had of necessity to be deferred to the end of the year. Such testing since then in effect confirmed the previous statements. They had now the crushing machinery for 700 to 800 tons per day capacity for the new mill en route from America; the purchasing of concentrator tables and the flotation machinery had been deferred pending the arrival of the construction crew, so as to allow the testing experts and management to continue their research in the test mill as long as possible. The housing for labour at the new mill, sidings, stone, sand, timber, etc., was now being arranged for. The 1,000 h.p. Diesel electric unit was started up in September, and at the end of the year some 16 electric motors were in operation. A second Diesel had been ordered; foundations and extension of building were being put in, and it was hoped that it would be in operation by the end of the year. A satisfactory arrangement had been completed with the Government for the use of Man-sam Falls, and preliminary work had been started. The geological department had been extended and was now undertaking the mineral reconnaissance of the surrounding country, and had done valuable work in reconnaissance for ironstone flux, other minerals and coal. The ironstone situation, which at one time gave anxiety, was now assured, the reserves at June 30 this year being estimated at half a million tons, and lignite and sub-bituminous coal areas near the property were now being investigated and prospected. During the next dry season—December to June—the company would maintain about four geological parties in the field, and it was hoped that such research would lead to valuable mineral discoveries. The staff generally had been very much strengthened and a strong esprit de corps had been developed among them. Together they formed a very strong volunteer company available for local military work. Regular weekly staff meetings had been established, the resident manager presiding, and at these meetings questions affecting all departments were discussed and arrangements made for the most effectual co-operation of all departments. An efficiency department had been created, the result of which amply justified its institution. This, briefly, was a statement of progress made during the year and, as intimated, it had been made under considerable difficulties due to the war, and great credit was due to their manager and his staff for the manner in which the difficulties had been met.

Mr. A. F. Kuehn, their consulting engineer, during 1916 made a visit to India, staying about a year on the property, which enabled Mr. Mitchell, the resident manager, to take a short and well-earned rest. During the period of Mr. Kuehn's stay important improvements were made in the local management, and the company was much indebted to him for the able manner in which work was conducted and the results attained. Mr. Macnutt, who was the resident manager up to the end of February 1916, left the company's service owing to illness, and having recovered his health was now on the Western Front as an officer with the Canadian Engineers. The technical committee, composed of highly qualified engineers and metallurgists, with Mr. T. J. Hoover as Chairman, used to direct the technical considerations and decisions regarding their property. This was the case up to May 1 when it was found that these gentlemen could only with the greatest of difficulty afford the necessary time to devote to the business. In consultation with the technical committee and with their full approval it was decided to relieve these gentlemen of their work, and it was unanimously agreed to ask Mr. Kuehn to become consulting engineer to the Board instead, an arrangement which had been carried out and which would give the Board practically the whole of his time to their work. Before leaving this matter, the Board desired to express their thanks to the members of the technical committee for the able manner in which they conducted their work during the period of their office.

The ore reserves at January 1, 1917, in the Chinaman ore-body were estimated at 3,644,000 tons, assaying 25·2 oz. of silver, 27·4% lead, 20·3% zinc, and 0·5% copper. This, as before stated, showed an increase of almost 60% over the ore reserves a year before, in addition to the fact that only 11% of the total was probable or partly proved ore, as against 24% for the year before. During the half-year ended June 30, 1917, the development work was almost entirely done in proved and probable ore, to facilitate the mining. They had also been extracting considerable amounts of zinc ore and been driving to connect with the vertical shaft section, both of which factors naturally had an adverse effect on the quantity of new exploration work. The proved and probable ore reserves in the Chinaman ore-body at June 30, 1917, as already stated, were estimated at 3,793,000 tons, assaying 25·7 oz. of silver, 27·9% of lead, 20·7% of zinc, and 0·5% of copper. At the sixth level, or Tiger tunnel level, they had a horizontal area of proved ore amounting to 23,904 square feet, assaying 29·7 oz. silver, 34·4% lead, and 15·8% zinc, and this ore was still in course of development. With this ore alone the ore reserve would be increased by 253,000 tons for every 100 ft. of depth. The probable ore at the end of June 1917, represented 9¼% of the total, as against 11% at December 31, 1916. It was to be particularly noted that the average showed ½ oz. more in silver, ½% more in lead, and 0·2% less zinc per ton than at the beginning of the year. The increase in total ore reserves since January 1, 1916, was 65%. During Mr. Kuehn's sojourn in Burma a graphic method of reporting ore reserve calculations and check sampling was instituted during each quarter-year, and they therefore had every confidence in the estimates. He had already referred to the completion of the Tiger tunnel up to the internal shaft, which had revolutionized the working of the mine. All pumping was now stopped, the mine draining through the tunnel, which was also the route used for transport of ore to the surface. The tunnel was now double track width up to the internal shaft and from there on single track width. The No. 4 level was now being pushed northwards to enable the virgin ground of some 600 ft. between the Chinaman ore-body and the vertical shaft sections to be prospected. At July 26 the drive lacked 200 ft. of connecting with the vertical shaft workings. The vertical shaft section block contained not only zinc and lead ore, but also some high-grade copper ore, but had been under water since the outbreak of war. The Tiger tunnel was officially opened by the Lieutenant Governor of Burma, Sir Harcourt Butler, who during his tenure of office had shown the greatest interest in the company's operations and twice visited the mines. He (the Chairman) had drawn the attention of shareholders to the square area of the proved ore at the No. 6 level and he left it to them to estimate the possibility of a large ore-body below the No. 6 level, as well as the possibilities in the block he had just referred to, and, further, the remaining unprospected ore-bearing zone. The smelting plant had been remodelled and added to in the face of difficulties in procuring materials and stores. The production of lead and silver during the year had been influenced by shortage of roasting capacity and ironstone fluxes, as well as the aforementioned stores. As to the roasting situation, five roasters were brought into successful continuous operation by the end of the year, and they were to-day constructing a sixth one.

He had already referred to the purchase of equipment for the two units of crushing, regrinding and jigging sections of the new mill, giving a capacity of 700 to 800 tons per day. The purchase of tables and flotation equipment was being deferred until the arrival of the construction crew, who should be in Burma any day now. This deferment would cause no delay as regards the beginning of operations of the new mill, and allowed them just so much longer to continue the testing work. Mr. Kuehn had referred at considerable length in his report to the testing, so that he would only add that in the last six months they had tested a further 3,722 tons of the first grade lead ore in the testing plant and under gradually improved conditions. The manager had just recently advised by cable that the test runs thus far made justified them anticipating that the new mill should on this type of ore attain a recovery in lead concentrates of not over 30% of the total zinc, and 75 to 80% of the total silver, and of 80 to 85% of the total lead contents of the ore. Owing to the desirability of proving the above first in preference to the zinc concentrate product, and to the multitude of handicaps brought about by the war, they had not thus far converted the residues into zinc concentrates on the mill output scale. The work was now in hand, and they hoped that it would confirm their anticipations that the new mill should attain a recovery from the said residues of 65% of the zinc content of the ore into zinc concentrates assaying about 45% of zinc. The large scale testing on the other types of ore would directly follow this. They were also conducting research work in the research plant at the property with a view to realizing on the zinc content of the lead concentrates, and perhaps ore, by leaching and electrolytic or other precipitation. They were also conducting large scale pyro-chemical metallurgical research work in the United Kingdom, which offered promise of profits over ordinary smelting operations. It was as yet premature to make any further comment and he only made mention of this phase to indicate that they were dealing with the question of the conversion of the ore into metals in a comprehensive manner. The Chairman concluded by giving details of the progress of the railway department and its administration.

Mr. F. A. Govett seconded the motion and it was carried uuanimously.

CHENDERIANG TIN DREDGING, LTD.

Directors: John I. Philips (*Chairman*), Sir Ernest W. Birch, W. A. Addinsell, R. L. Corbett, James Sellar. *Secretaries*: Bright & Galbraith, Ltd. *Office:* 7 Martin's Lane, Cannon St., London, E.C.4. *Formed* 1914. *Capital* issued: £92,500 in £1 shares.

Business: Operates alluvial tin ground in Perak, Federated Malay States; is a subsidiary of F.M.S. Timah Ld.

THE third annual general meeting was held on July 26 at the Cannon Street Hotel, London, E.C., Mr. John I. Philips (the Chairman) presiding.

Mr. H. A. Huntley, on behalf of Messrs. Bright and Galbraith, Ltd., the Secretaries, read the notice convening the meeting and the report of the auditors.

The Chairman said: Gentlemen,—I have no doubt that you have all carefully read the report and studied the accounts which have been in your hands for some time now, and that it will be your pleasure to take these as read. I propose dealing in the first place very briefly with the accounts, which clearly show the position of affairs and need little further explanation from me. Our property account remains exactly as in the last balance sheet, no additions having been made during the year. Small increases will be observed under the headings of development, buildings, plant and machinery, but there are no exceptional items of expenditure under these headings. There is, as you will observe, a considerable increase in the amount of sundry spares, including spare parts of the dredge, and I think that under existing circumstances this increase is a matter for congratulation, as it indicates that we have on hand a satisfactory supply of spare parts, which are exceedingly difficult to obtain at the present time, and upon which the continuance of dredging operations entirely depends. It has been a matter of no little difficulty to provide the necessary spares comprised in this item, but by dint of perseverance and a considerable amount of hard work the company has been placed in a most gratifying position in this respect. Turning now to the profit and loss account, it is somewhat disappointing to observe that the profit realized is substantially less than for the previous year. On the other hand, the expenditure has been kept down to most reasonable proportions, and in view of the great increase in the cost of all materials, fuel and labour, the comparatively trifling increase in working costs is evidence of most careful supervision on the part of the manager and the local agents. Last year I told you that a slight increase might be looked for, as the cost of all dredge material had risen considerably, and the expenditure on repairs and renewals during the first year's operations would naturally tend to be at the minimum point. As a matter of fact, however, the total working costs have only increased from 3·5d. to 3·65d. per cubic yard—that is one-seventh of a penny—and this expenditure includes the tribute of 8% payable to the original lessor. The decrease in the profits earned therefore cannot be attributed to increased expenditure, but entirely to the poorer ground which has been met with. Unlike some other forms of mining, it is impossible when dredging to pick or choose the ground which is to be dealt with in any given period, except to an exceedingly limited extent, and the dredge must work through good and bad ground as it is met with. During the past year we have met with a good deal of very poor ground, and in consequence the average value has declined from 0·72 to 0·53 lb. per cubic yard. It is impossible to say when we shall be encountering ground of higher value, but we shall doubtless do so in due course, and in the meantime, with the present high price of tin, the margin of profit has improved since the date of the accounts. The dredge itself has continued to give the utmost satisfaction, and it will be seen from the excellent running time that we had no stoppages for repairs worth mentioning. In the hydraulic elevating section results were not quite so satisfactory, as although the output was very little less than in the previous year the expenditure on revenue and capital account absorbed the greater portion of the revenue obtained from this section of the property. This was due mainly to several breakdowns, caused by abnormal rains, and could not have been foreseen. I am very pleased to say, however, that an arrangement has now been come to with a substantial Chinese contractor whereby the elevating section of our mine has been sub let on the satisfactory tribute of 50% of the tin ore won. After providing for the 9% payable to the lessor, this leaves the company as net revenue no less than 41% of the ore recovered, and it is the opinion of the manager and local agents that this arrangement will result in a considerably increased revenue to the company. This arrangement commenced on the April 1 last. Last year I referred to the question of excess profits duty, and I am very glad to say that we have been able to satisfy the authorities that this company is not liable for any duty in respect of either of the two accounting periods which have been completed.

Finally, there is one important matter to which I am sure you would like me to refer, and that is the acquisition of further areas, regarding which we were negotiating when I last addressed you. You will no doubt remember that I then advised you that we had obtained options over some 250 acres of adjoining land, and had arranged for an engineer to immediately test this area. I would like to explain that an enormous amount of work was entailed in acquiring the options referred to. A large number of individual native owners had to be dealt with and numerous titles investigated. In connection with this work we are greatly indebted to the tact and perseverance of our agent, Mr. A. M. Sellar, and our manager, Mr. J. W. H. Fenner. It will, I feel sure, be your pleasure that I should convey on your behalf to the manager, the local agents and the staff in the East a hearty vote of thanks for their services during the past year. Their work has been performed in a highly creditable manner, under circumstances rendered even more difficult than usual owing to war conditions and ever increasing difficulties in obtaining supplies, and I am sure it will be an encouragement to them to know that their efforts are appreciated. The area eventually taken up under option comprised about 310 acres, divided into 48 different holdings. On this area 315 bores were put down, and the results show that about 247 acres are dredgable at a profit, the average value being at least equal to that of our original property. Negotiations are still proceeding with a view to obtaining more favourable terms for some of the blocks, and up to the present time about 142 acres have been definitely secured. This increase in the extent of our property will supply ample work for a second dredge immediately conditions are sufficiently favourable to enable this to be put in hand, and I hope the ultimate result will be a substantial increase in the return to shareholders. Naturally this extension of area will also considerably lengthen the life of our mine, and for this reason the board has not considered it necessary to commence providing for the amortization of the cost of your property, although it is our intention to do so in due course. We have, however, once more provided for depreciation of the dredge and other plant and buildings on a liberal scale, and propose writing off the balance of preliminary expenses—an item which it is always satisfactory to eliminate from our balance sheet. After making these allocations, and presuming that you will approve of the dividend now recommended, we are still able to carry forward the substantial balance of £3,412 to the next accounts. The dividend of 5% is free of income tax, and I would call your attention to the fact that this means that the shareholders are really receiving a dividend of 6⅝%.

Sir Ernest W. Birch seconded the resolution, which was unanimously adopted.

ROPP TIN, LIMITED.

Directors: Edmund Davis (*Chairman*), Lord Brabourne, C. H. Holland, J. C. Prinsep. *Secretary:* H. St. John Hodges. *Office:* 20 Copthall Avenue, London, E.C. *Consulting and Superintending Engineers:* Consolidated Gold Fields of South Africa. *Formed* 1911. *Capital* issued: £45,000 in shares of 4s. each; debentures £53,980; 6% loans £16,000.

Business: Operates alluvial tin ground by calabashing and hydraulicking in Northern Nigeria; two bucket-dredges are about to commence work.

THE fifth ordinary general meeting was held on July 18 at 8 Old Jewry, London, E.C., Mr. Edmund Davis (the Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that during the year they had produced 467 tons of tin concentrates, assaying 71·91%, which had realized £55,352, being £118. 10s. 6d. per ton of concentrates. Expenditure in Nigeria and London, as well as depreciation of plant, machinery, buildings, furniture, and prospecting and development, came to about £67 per ton, leaving a margin of about £51 per ton. At the last meeting, when dealing with the position of the company, they included in expenditure income tax, debenture interest, etc., and, therefore, for the purpose of comparison, it was necessary to include these, increasing the cost from £67 to £85, comparing with £79 for the twelve months ended December 31, 1915. This left a balance of £33 per ton, comparing with £34 for the previous year and £25 for the year ended December 31, 1914. The result of the past year's operations, as set out in the profit and loss account, showed a balance profit of £15,568—or £33 per ton—comparing with £13,947 or £34 per ton for the previous twelve months. The available balance, as shown in the balance sheet, was £24,721. Out of this they intended to recommend the payment of a dividend of 1s per share, free of income tax, which would absorb £11,250 and leave £13,471 to be carried forward. Now that the construction of one dredge would be practically completed and that of the other in a very forward state, they would obtain working results at an early date, and therefore it was not necessary to give at the moment any estimate of what production and profit might be, it being preferable to make a definite estimate when the plant was running. They estimated that they would recover from the property 12,226 tons of tin concentrates. If the two dredges worked in a satisfactory manner and calabashing was continued, the output might be at the rate of 1,500 tons per annum, giving an eight years' life. Taking the figures for last year they had the following:—Proceeds of 467 tons, £55,352. Against this they had outlayed in Nigeria, £24,960; in London, £1,561; depreciation of plant, £3,062; and prospecting and development, £1,683, making a total of £31,266 and leaving a balance of £24,086, or, roughly, a profit of £50 per ton. On 1,500 tons this would be £75,000 per annum.

Lord Brabourne seconded the motion, which was carried unanimously.

THE MODDERFONTEIN DEEP LEVELS, LIMITED.

Directors: H. Newhouse (*Chairman*), H. C. Boyd, W. R. Crowhurst, F. R. Lynch, V. J. Ronketti, W. Ross. *Consulting Engineer:* P. M. Anderson. *Manager:* H. R. Hill. *Secretary:* C. L. Chalmers. *Head Office:* Johannesburg. *London Secretary:* H. Rogers. *London Office:* Pinners Hall, E.C.2. *Formed* 1899. *Capital:* £500,000.

Business: Operates a gold mine in the Far East Rand; controlled by A. Goerz & Co.

THE annual general meeting of shareholders was held at Johannesburg on June 13, Mr. H. Newhouse presiding.

In moving the adoption of the directors' report and accounts, the Chairman, in the course of his remarks, said: The working profit of £486,963, or 21s. 5·4d. per ton milled, was respectively £148,534 and 4s. 1·2d. per ton more than that of the previous year, the highest monthly total being £46,916 in August and the highest rate slightly over 23s. per ton milled in December. The current year's operations have yielded a still higher average, the working profit of £222,677 to May inclusive being at the rate of over 22s. per ton milled. For the current half year it is anticipated that profits, including interest, will total £271,000, as against which capital expenditure, etc., will absorb, say, £20,000, and taxes £32,000, leaving for distribution £219,000. The company is, therefore, in a position to pay a dividend of 8s. 6d. per share. The amount invested in stores has, however, been further increased by about £14,600, and the directors have, therefore, decided to distribute 8s. per share. Though to prophesy is always dangerous, and particularly so in these times, I think it is legitimate to hope that for the reasons above given, the dividend for the second half of this year will show a further increase, unless anything unforeseen occurs. At the time of writing his report, which is before you, your consulting engineer estimated that the capital expenditure during the current year would be chiefly in connection with the new 65-drill compressor and more housing accommodation, and would amount to less than £25,000, but since that date your board has decided to make some further improvements at a probable cost of about £6,000. It is anticipated that these will be completed within about three months hence, and will have the effect of enabling the tonnage milled to be increased by about 1,500 tons per month, and the monthly profits by about £1,800. I may say that the mine is well able to supply this increased tonnage, and the reduction works should deal with it without difficulty. I feel sure one of the most satisfactory features in the reports before you will have been the amount of development work done during the year, and the value of the ore disclosed thereby. The total of 6,134 ft. was 74% greater than that of 1915, and was much more than sufficient, both in tonnage and in value, to maintain the ore reserves position, as you will have observed from the figures published, which showed the gratifying increases of 650,000 tons and 5 inches in the width while the value was also somewhat higher at 8·4 dwt. The 3,320,000 tons developed at the end of the year are sufficient to feed the present mill for approximately seven years, and their profit value exceeds very considerably the market capitalization of the company. Since the end of the year, development has continued to be highly satisfactory, the footage sampled aggregating 2,105 ft. of a value of 12·9 dwt. over 50 inches, the aggregate in accordance with the custom of the company including both the pay and unpay footage. It is appropriate at this point to call attention to the important influence on the total ore contents of the mine—and, therefore, on its life—of the increase in the calculated stoping width. The increase of 9 inches during the last two years means approximately 4,000 tons per claim.

The report and accounts were adopted.

The Mining Magazine

FOUNDED IN 1909 BY T. A. RICKARD AND EDGAR RICKARD.

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.SC., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill,* both Editions.

BRANCH OFFICES { 420, Market Street, San Francisco. 2,124, Equitable Building, New York.

SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XVII. LONDON, SEPTEMBER, 1917. No. 3.

CONTENTS.

EDITORIAL

METALLURGISTS in search of revised terms in connection with the nomenclature of non-ferrous alloys might take a hint from the schoolboy who, according to the Hon. and Rev. Edward Lyttelton, in a paper in the September *Nineteenth Century and After*, defined "Copernicus" as a mixture of copper and nickel.

TIMBER for the British coal mines has to be drawn largely nowadays from home resources, owing to the closing of the Baltic and to the necessity for economizing ship space. The Controller of coal mines is now organizing a system of cutting and distribution. It is a relief to find that both the Government authorities and the land-owners are awake to the necessity for the establishment of intelligent methods of forestry, and that the woods are not to be sacrificed without thought for the future.

TWO new Orders have been instituted for the especial purpose of recording the public services rendered in connection with the war. Among the Knights of the Order of the British Empire we find Mr. C. W. Fielding, chairman of the Rio Tinto, and Mr. H. Percy Harris, chairman of the St. John del Rey, while among the Companions of the Order is Mr. F. W. Harbord. The other Order, that of the Companions of Honour, has been bestowed on Mr. Kenneth B. Quinan, manager of the Cape Explosives Works.

EARL GREY was a pioneer of Empire in his capacity as administrator of Rhodesia in its early days, and subsequently as a director of the Chartered company. As governor-general of Canada he did much to promote friendliness and mutual respect between the United States and the Dominion. A man of receptive and enterprising mind, not steeped in class prejudice, unencumbered by inertia, preferring the spring to the autumn, desirous of solving the drink problem by reasonable and kindly methods: that is our inscription for his tombstone.

PETROLEUM resources in the British Isles are receiving the attention of the Government. The exclusive right to win petroleum is to be vested in the Crown, and a bounty of ninepence per ton is offered to licensees. Much attention has been devoted to the subject recently in our columns, liberal quotations having been given from papers on the Norfolk shales and the Kimmeridge shales, and on the petroleum resources of the kingdom. We have every confidence in the views of the Government's advisers who have prompted this new departure.

THE United States Bureau of Standards, in consultation with representatives of technical societies and of trade interests, has prepared a new set of standard screens. This series is thoroughly sound scientifically, being based on the metric system, the width of aperture, and the diameter of wire. The "mesh," with its wire and aperture of equal width, is properly banished. We intend to describe the series at length in the next issue.

CABLE advices announce that the Miami Copper Company has abandoned its intention of appealing to the Supreme Court of the United States against the judgment of the Philadelphia Court in favour of Minerals Separation. Furthermore, in the case of Minerals Separation against the Butte & Superior, the judge has held that oil used in excess of 1% also infringes the patents. Comment is postponed until particulars arrive by mail. The key to the above bald statement of news is provided by an editorial in our last issue.

MANY subjects connected with engineering and technology, while of interest to readers, cannot appropriately find a place in our Mining Digest. For instance, *The Engineer* is publishing articles on the evolution of the caterpillar tractor, and a recent issue of the *Journal* of the Society of Chemical Industry contains a paper on the history of the production of artificial silk. Both of these are papers of prime importance. For the benefit of readers who may suspect us of humorous proclivities, we desire to say that there is no connection between the two papers.

MINING companies always make liberal allowances for depreciation of plant, and are often exhorted to make similar allowances for depreciation of property. Why not write down the membership of the board of directors also? We often have to record the results of a mining company that has not paid a dividend for several years and is not likely to pay any more; yet the board may consist of seven or more members who draw between them anything from £1,000 to £5,000. Individual probity of character is not considered on the battlefield, and the luck of events is borne with good temper. Similarly why should not some of the directors of a mining company submit in altruistic frame of mind to the same sacrifice?

METHODS of publicity characteristic of the Alaska Treadwell group were never ideal, and shareholders and the public seldom received any really useful information. The latest example of this carelessness or indifference on the part of those in authority is provided by the distribution last month of reports for the year 1916 containing no mention whatever of the great catastrophe.

IN this issue we publish an article describing the method of mining at Ashanti, where the lode and walls are unusually soft. Attention is increasingly given nowadays to careful methods for the prevention of caving. Soft ground obviously requires more immediate attention, but hard rock is eventually as treacherous, as is proved at Alaska Treadwell, on the Rand, and in the Indian mines. We take this opportunity of inviting readers to contribute their experience relating to methods devised for mining in soft ground, for preventing rock bursts, and for ensuring the safety of the hanging wall.

Percentages of Recovery.

The daily papers did no great service to the Burma Corporation, or for that matter to the principles of technology, when they referred at some length to a table of figures exhibited at the recent meeting of shareholders of that company giving the total metal, in tons or ounces, contained in the ore reserve. These figures were not given in the yearly report or in the reports of the meeting, for both Mr. A. F. Kuehn, the consulting engineer, and Sir Trevredyn Wynne, the chairman, were not anxious to make statements that are easily misinterpreted by a thoughtless and often greedy public. On the contrary, the difficulties attendant on the separation of the constituents of a complex ore and the extraction of the metals from these concentration products were fully described by those in control, and approximate estimated percentages of recovery to be expected when the concentration plant is erected were duly set forth. In spite of these precautions we find that many people regard the totals as representing a gauge of the gross income to be expected when the ore is raised and treated. In connection with a similar problem, that of the Sulphide Corporation, we explained the many factors that cause the wide gap between theoretical and realized income, and we must refer readers to that article, contained in our issue of April 1912. Briefly, we may say that in the first process of obtaining products, one high in lead, and the other high in zinc, some of the sulphide is lost in the tailing. Then all the zinc in the lead concentrate is lost in lead smelting, and some of the zinc and lead is lost in zinc smelting. If the lead and zinc concentrates are sold, so much of the contents are not paid for, and in some cases even deductions are made for their presence, that the gap between total receipts and total theoretical value is still further widened. The losses of silver have also to be considered, for the zinc smelter pays nothing for the silver in the concentrate. The real reason why the total content is calculated is to privately show the shareholders, directors, and metallurgists how much they are losing, and therefore to spur those in authority to greater efforts. Knowing the many opportunites for loss according to present methods, the directors of the Burma Corporation wisely decided to experiment on other metallurgical methods. Before the days of flotation many wet and fire methods were devised, but without success. Recently electrolytic methods have been revived with promising results, and there is no reason why riper experience should not make something of the fire methods. The Burma Corporation is, in this connection, testing several processes, but it is not appropriate to discuss details during the experimental stage. Our only reason for referring to the matter is to encourage metallurgists to have another try at a number of the older, and hitherto unsuccessful, methods.

America at War.

It is with unusual pleasure that we print this month a communication from Mr. T. A. Rickard entitled "Our American Friends." In the first place, it enables our readers to enjoy once more a characteristic essay by our foremost and most forceful writer, full of shrewd observation and phrased in true rhetorical style. Secondly it gives us the opportunity of saying a few words of our own on the past and present position of the United States with regard to the war. From August, 1914, to February, 1917, the tendency in this country was to picture President Wilson as a weak-minded spinster, incapable of playing a man's part, a victim of the dollar snatchers, and heedless of the sufferings of

France, Belgium, and Poland. The publication of Ambassador Gerard's book has been of incalculable service in placing a different complexion on the relations of America, Germany, and Great Britain during the early period of the war. From the beginning both president and ambassador were fully aware that the Kaiser and his minions were acting as lying bullies and that they had America on the list of things to be strafed. Other recent events in this country and America have shown us, as Mr. Rickard says in his letter, that the President could not adopt the policy of the thick stick advocated by a strenuous predecessor, for he had no thick stick, nor a sufficient number of followers to wield it. The first inconveniences arising out of the war suffered by Americans were due to the blockade of Germany instituted by England, and the influence of war on the interests of individuals, singly or collectively, is undoubtedly not in favour of the disturbing party. But the greatest stumbling block to action was the fact that the United States is a composite nation. It is true that the administrative classes and the leaders of thought are of English ancestry and English in sympathy, but the vast bulk of the population is an olla podrida of refugees from every country of Europe, knowing nothing of England or her principles and aims. We may take it that ninety nine per cent. of the European population of the United States left their countries of birth to escape poverty and the cruelties of the military machine. They now enjoy the inestimable privilege of living in the land of the free. Could it be expected of such citizens that they should itch to shoulder a rifle again in quarrels that do not concern them personally or as a body? Nay, would not many of them, even if actuated by altruistic motives, hesitate to take arms against their fatherland, which though associated with unhappy recollection still contains many friends and relatives? Such was the position confronting President Wilson. It cannot be said that England has been free from similar delays and hesitations. It took two years to introduce compulsory service, and even now the working man has to be treated as deferentially and judiciously as a distinguished courtesan. Mr. Rickard tells us that if we visited the United States we should find many strange languages and unaccustomed racial characteristics. This was impressed on us on our first visit to America in 1892. When the customs tug approached our ship outside the Narrows it was crowded with so many foreigners, either officials or visitors, that a fellow traveller, a well known professional comedian, was prompted to exclaim: "A blooming cargo of bally Deutschers!" On landing, we stayed at Hoffman House, paid a call at Havemeyer Building, ate a Hamburger steak at Schwarz's, noticed that the names over the shop doors were either O'Flaherty or Krohne, got lost in the Chinese mazes of Mott Street and the Polish quarters in Hester Street, then tried to talk the language of Hoboken. Finally we asked to be shown where the Englishmen lived. This experience provides our endorsement of Mr. Rickard's presentation of the case, and serves to illustrate President Wilson's difficulties, now happily overcome.

Electric Winding.

In this issue we present the first instalment of an article which outlines the modern methods of electric winding. It is not the intention of the author to deal with winding problems in general, but merely to demonstrate the applications of electric power for this purpose. There are two ways of starting a discussion of this subject; one from the point of view of the designer or maker of machinery, and the other according to the every-day experience of the user. In the present case the author represents the designer, and seeks to indicate, in moderate language, what the electrical engineer can do to facilitate the raising of ore or coal to the surface. On another occasion we hope to present one or more articles giving the experience of mine managers, and we may take this opportunity of inviting contributions of this nature. There are many who hold that articles and papers written by inventors or manufacturers should not appear in the pages of a technical magazine or in the transactions of a professional society. As with most sententious sayings, the value of this remark depends on the application of it. Our own view, as the editor of a magazine, is that if an inventor or manufacturer can tell us something new, or can give the outlines of a problem particularly clearly, there is no reason why he should not be allowed to do so. We recognize, however, that the position of a society in this matter is governed by entirely different considerations.

The question of the advantages of electric winding is one which cannot be answered offhand. It depends on a great variety of factors, and on the varying conditions ruling at each particular locality, so that whether it will pay to adopt the system at a new mine or to substitute it for steam at an old one can only be decided by careful study of the conditions in each case. But there are a certain number of considerations that always have to be kept in view, and it is advantageous to review these in a general way.

To begin with, it would not pay to use electric winding, under normal conditions, if winding were the only mechanical requirement, for the work done is too intermittent and irregular in amount for electrical efficiency. If, however, hydro-electric power was available and fuel scarce, the position would naturally be different. As a matter of fact the mines usually also require power for pumping, ventilating, and for driving air-compressors and metallurgical plant, as well as for winding. These other plants work at practically constant load, so that when they draw their current from the same source as the winding engines, the maximum and minimum loads on the electrical plant are within proportionally much narrower range. But in this case also it is necessary to consider the relative availability of hydro-electric power and fuel. Then again though water might be available for generating electric power, it would not necessarily be available for steam raising; for instance, if the river was in another valley or the mine at great altitude. At one time it did not pay to operate an air-compressor electrically, and the necessity for working a reciprocating compressor by steam offered sufficient inducement to adopt steam-winding. This has all been changed during the last year or two, for the compressors have been speeded up sufficiently to meet the requirements of the electric motor. As regards the metallurgical plant, it may prove uneconomical to gear the high-speed motor down to the slow movements usually required. On the other hand the advantages of electric power are very great when underground plant is required, as in the case of a winder for an internal shaft. The distribution of power electrically from a single station at a mine is more economical than its generation by a number of detached steam plants, for the efficiency of one large plant is greater than that of a number of small ones, and the amount of labour employed is less.

So far we have considered only the case of a mine that has to generate its own power. The cost of current can be reduced and the equalization of the load increased by a number of mines drawing their power from a common source. Such a power station may be run co-operatively, or it may be established by an independent party or a municipal authority. Unless, however, the mines have some control of the power producer, their share in the financial advantage accruing from large-scale operations may not be substantial. This oblique reflection on the perspicacity of the power companies is not warranted so much now as it was a few years ago. The existence of a supply of electric power is of advantage to a new mine, for it obviates the necessity of erecting a power-generating plant. Before leaving the subject of source of power, the position of the coal mines in this regard should be mentioned. In the early days they had an economic advantage owing to the fact that they could use coal of little or no market value, "slack" or "dust," which was then practically unsaleable. Their power costs thus did not include the cost of coal, and the electric current was correspondingly cheaper. Of recent years, however, this small coal has been in demand, owing to the improvements in steam-raising furnaces, and also for the manufacture of fuel blocks, so that it is now necessary to charge the value of such coal in estimating the cost of current. In spite of this consequent increase in cost, the electric drive holds its own, owing to the many compensating advantages. To sum up, we may say that, from the point of view of both first cost and working cost, the electric drive is rather more expensive than the steam drive. This general principle holds good when the conditions are such that both methods are equally available; the relative availability introduces the other factors which we have mentioned.

Having thus given due consideration to costs, we can discuss the relative mechanical advantages of electricity and steam. The most important of these arise from the fact that the torque, or twist, of the winding drum is constant throughout the revolution, whereas, in the steam drive with an engine at each end of the drum, there are four dead-centres during each revolution. This irregularity of the pull in the steam drive gives rise to wide variations in the tension in the rope, and causes the rope to vibrate and swing dangerously. The even pull of the electric drive preserves the life of the rope, and also makes it possible in some cases to use a lighter rope for the same weights. For the same reason a much higher speed is allowable, it is possible to use tail ropes for a greater depth, and the chances of slipping on a Koepe pulley or Whiting hoist are reduced. Another advantage accruing from the electric drive, particularly in connection with the Ilgner and Westinghouse systems, is that the energy absorbed in retardation is stored and becomes available during the next acceleration. The point in connection with relative advantages of the electric and steam drives that causes the greatest amount of controversy relates to the methods of control of operations. Our author, Mr. Evans, has a good deal to say on this branch of the subject, and he describes the apparatus for starting and stopping, the brakes, overwind preventers, and other safety devices, and he makes a good case for the superior efficiency of modern electric control. The only criticism to be put forward by advocates of steam is that electric control devices are complicated, and that automatic apparatus is not infallible. We have now said sufficient as an introduction to the general question of electric winding, in order to help those not already having experience on the subject to grasp the main facts.

The Nickel Commission's Report.

The report of the commissioners appointed by the Ontario Government to investigate the nickel position can fittingly be described as monumental. It takes rank among the best and most complete monographs ever published. That the information is not absolutely complete is no fault of the commissioners. They had to respect trade secrets, so that the details of practice in connection with the operation of the processes for refining the matte could not be published. The International Nickel Company refused to talk, or to permit the commission to visit the works at Bayonne, in the outskirts of New York, but the Mond Nickel Company and the owners of the Hybinette process granted facilities under the bond of secrecy. The outlines of these three processes are given, though of course much of this has been published before. We are not among those who demand full disclosure of works practice, though naturally a "scoop" of this kind would be dear to the editorial heart. Thus we can take the omission of these details philosophically.

The commission was appointed in September 1915, and was composed of Messrs. George T. Holloway, Willet G. Miller, McGregor Young, and Thomas W. Gibson, representing repectively metallurgy, geology, law, and administration. After pursuing inquiries in Canada, the United States, Norway, and New Caledonia, and taking evidence in London, the commission was able to deliver a report in March of this year. Owing to the voluminous nature of the report its publication in full was delayed until August, but in the meantime the chapter containing the summary and conclusions was circulated. In our April and May issues we briefly announced that the commission was of opinion that there was no obstacle to the refining of nickel matte in Canada, especially if the Hybinette electrolytic process was adopted, and in the June issue we made brief reference to this process. Quotations have been given from advance sheets of the report in English and Canadian papers, but for ourselves we preferred to await the full text.

The report is issued as a large octavo volume of 800 pages, with a great many photographs, geological maps, and plans of mines and works. In an appendix is printed the parts of the evidence that were not confidential. The volume begins with the summary and conclusions, which were circulated in advance, as already mentioned. The next chapter recapitulates the many suggestions and endeavours for the establishment of a refining industry in Canada. The economics and the political phase of the subject having here been stated, the commissioners proceed to the technology of nickel. The first section of this subject is naturally the history of the discovery and development of the Sudbury nickel-copper deposits. This chapter contains details of a romance of mining, particulars of which most of us never knew before and which the rest of us had forgotten. For this reason we beg leave to give some quotations. The first mine in what is now known as the Sudbury district, that is to say, that part of Ontario abutting on Lake Huron, was the Bruce mine. This copper deposit was discovered in 1846, and was worked with more or less success by several parties for a considerable number of years. At the present time the copper-bearing silica is used by the Mond Nickel Company as a lining for its converters. In 1848 the presence of nickel in iron sulphide was first detected. This was at the Wallace mine, but the property was never rich enough either in nickel or copper to warrant development. The first hint of the existence of an important deposit came in 1856 when a survey party noted exceptional influence on the magnetic needle, due, they stated, to the presence of iron ore. The presence of disseminated nickel and copper at this deposit was proved in 1883, but it was not until 1885 that the value of the deposit was recognized. Subsequent development revealed immense masses of nickel-copper ore, and, as the Creighton, it has since been, and still is, the biggest producer of nickel in the world. The discovery of the Murray mine antedated by two years the staking of the Creighton claims, and from the point of view of the establishment of a nickel industry in Canada it was a more important landmark than the opening of the Creighton. The disclosure of the Murray deposit affords a conspicuous example of fortuity in mining, and of the value of a railway as a prospecting agent. One of the contractors engaged in the building of a branch of the Canadian Pacific, John Loughrin, saw sulphides in a cutting in 1883, and with Thomas and William Murray, local merchants, made a purchase of claims early in 1884. The Murrays interested the Vivians, and the first furnace was erected in 1889. The bessemer product was shipped to Swansea, but after four years the mine was closed, as the Vivians were able to secure a better business in connection with New Caledonia ores. The further history of this property is given later. The services of the railway in connection with the unearthing of the nickel deposits is all the more remarkable owing to the fact that the Cobalt ores not far away were discovered in the same accidental manner. And here we may remind our lay readers that the Cobalt ores contain nickel, and that some of the Sudbury mines contain the precious metals. In fact the Vermilion was originally opened as a gold mine, and at the present time yields valuable amounts of platinum, which occurs as sperrylite, the arsenide. As we have said, the Creighton formed the basis of the first permanent nickel-mining operations. The property was acquired by the Orford Copper Co., of New York, and the operations were conducted by the Canadian Copper Co., a corporation organized for the purpose. Subsequently the International Nickel Co. was formed in New York in 1902 to acquire control of the Orford and Canadian companies and to seek for business also in other parts of the world. The next company of importance to be formed was the Mond Nickel Co. As the commissioners mention, the process was in this case invented before the supply of ore was obtained. The process of Ludwig Mond, Carl Langer, and Frederick Quincke is essentially different from the others, for it depends on the volatility of a nickel compound. In order to apply the process profitably, it was decided to buy a mine, and thus the troubles of a patentee on the look-out for royalties were avoided. The McConnell property was bought, and its name changed to the Victoria. Since then several other properties have been acquired, and in addition the ore produced by the Alexo Mining Co. is purchased. We now return to the Murray mine. After being abandoned by the Vivians, several attempts were made to revive it. Among other investigators was the Mond Nickel Co., but as the results obtained by diamond drilling were not satisfactory the option was not exercised. Finally the late Dr. F. S. Pearson, who lost his life on the sinking of the Lusitania, obtained control of the Murray and other mines and purchased the rights in the Hybinette process. His death delayed fruition, but eventually his company, the British America Nickel Corporation, was fully established. The British Government is a shareholder, as also is the Norwegian Hybinette company. With Messrs. W. A. Carlyle and E. P. Mathewson in charge of the mining and metallurgical departments, the success of the company is assured.

We have said so much about the history of nickel mining in Canada that little space is left for adequate notice of the remainder of the report. The next chapter deals with the geology of nickel deposits, the origin of nickel ores, descriptions of individual mines, their methods of development, and the nature of their ore deposits. It is of interest to note that Mr. Cyril W. Knight contributes the section on the origin of the ores, and he is thus able to bring forward his views, quoted in our issue of June, 1916, controverting the magmatic segregation theory. We shall publish an article shortly giving another explanation of Mr. Knight's evidence. In this chapter are included accounts of deposits in New Caledonia, Cuba, and other parts of the world. The Cuban deposits are nickeliferous iron ores, and American smelters are using them for the production of nickel steel direct. Other chapters deal at length with nickel steel, with the great variety of non-ferrous nickel alloys, and with the various uses of nickel and its compounds. The commissioners are not able to obtain statistics of the proportion of the output employed for each individual use. This fact relieves us from the stigma of ignorance which has rested on us from time to time when we pleaded the same want of information. Another large section of the book is devoted to smelting methods, the refining processes, and the recovery of accessory metals. The bibliography of nickel is valuable, and the notes of evidence provide lively reading occasionally, with plenty of personal reference. Among the many witnesses we may pick out Sir Alfred Mond. He settles some of those disturbing points that have been full of uncertainty. Notably he stated that there has never been any pool among producers restricting production and regulating prices. We have arrived at the end of the space available for this review long before we have said all we wished to say, so we must conclude by thanking the commissioners for the immense amount of hard work they have done, and congratulating them on the excellent quality of their contribution to mining and metallurgical technology.

REVIEW OF MINING

Introductory.—Depression has settled on the country owing to the serious condition in Russia, and many are the anxious forebodings. Moonlight air-raids have not exactly acted as a tonic. The copper and zinc positions are now better in hand. Lead has been taken under entire Government control, as also have chrome ores. Silver has been soaring, owing to continued demand and absence of spot supplies in London. Large amounts are exported from San Francisco to China and the East. The Indian government has prohibited imports and exports of silver. In that country silver is now worth much more as bullion than as currency. There is some talk of demonetizing silver in the United States. At the time we go to press, September 11, the quotation is 50d. per standard ounce.

Transvaal.—The output of gold during August was 731,405 oz. on the Rand, and 25,253 oz. in outside districts, making a total of 756,658 oz., worth £3,214,079, as compared with £3,219,094 in July and £3,318,116 in August of last year. The number of natives employed at the gold mines at the end of August was 170,817, as compared with 171,653 at the end of July and 194,112 at the end of August, 1916.

Modifications are to be made in the terms of the lease of the Government Gold Mining Areas (Modderfontein), whereby the Government's share in the profits is decreased. It will be remembered that this area was the first offered on lease, and that the terms agreeable to the Barnatos seemed onerous. In fact the large percentage to be paid as Government share when the profits were high acted somewhat as a damper to the development, on this system, of the Far East Rand. The terms subsequently accepted by the Government for other areas have been far more favourable to the operator, so that a modification of the Barnato contract is only equitable. By the new arrangement it is estimated that, at the current rate of output and cost, the Government's share of the profit will be reduced by 17½%. It is well enough for the Government's share of the profits to advance with an increase in the yield per ton, but when the extra profit is gained by a reduction of working cost the same advance is not so palatable. This company has had a long fight to arrive at a dividend-paying stage. It is expected that the first distribution will be announced in December.

Arrangements are being made to amalgamate the Consolidated Main Reef and the Main Reef West. These two companies belonged to the Neumann group, and have recently been acquired by the Central Mining Corporation. The mines are in the middle west Rand, being to the west of Langlaagte, and east of the Bantjes. The West mine is not in a strong financial position, and the repayment of debentures had to be postponed in order to supply funds for deeper sinking. From 1910 to 1912 fairly good dividends were distributed, but no dividends have been possible lately. The Consolidated Main Reef has been a steady dividend payer for many years, though the rate has always been small.

The East Rand Proprietary's monthly reports are gradually becoming worse. For August the yield per ton showed a further fall, £144,278 being extracted from 151,000 tons, as compared with £149,161 from 150,000 tons in July. The working profit was nominal, being £100, as compared with £6,432 in July. The directors complain of a serious shortage of labour, and of a continuous increase of costs.

The value of the output of diamonds in South Africa during the first half of 1917 is officially reported at £3,814,344, of which the Kimberley district (De Beers and Jagersfontein) contributed £2,194,000, the Pretoria district (Premier) £664,000, and the Klerksdorp alluvial fields £200,000.

Rhodesia.—The official return for the output of gold during July is the lowest for two and a half years, being £288,731, as compared with £302,195 in June, and £322,365 in July last year. As intimated last month, the Eldorado is reducing its output; otherwise the decrease is due to shortage of white labour, and to the closing of some of the smaller properties worked by individuals.

The Rezende Mines company has been very much before the public recently. Since the yearly report was published, an abstract of which was given in our August issue, announcements have been made of the discovery of comparatively high-grade ore in the Eastern section. More recently it has been announced that Sir Abe Bailey has acquired control from the Farrars, and the shares advanced to over £3, as compared with 7s. 6d. a year ago. It is stated that Sir Abe Bailey has formed a company called the Anglo-American Rhodesian Exploration Co. with a capital of £250,000 to acquire his Rhodesian assets, and that he has sailed for New York, where he is receiving financial backing from unnamed parties. Messrs. S. R. Jameson and W. J. Gau have been appointed consulting engineers to the group. This is the second recent instance of American capital becoming tentatively interested in South Africa, the other case being that of Mr. Isaac Lewis and the Far East Rand.

The report of the Shamva Mines for 1916 is somewhat belated, but it is made interesting by the inclusion of a short report written toward the end of June by Mr. Cyril E. Parsons, the successor to the late Mr. H. A. Piper as consulting engineer. Those who read the articles appearing in the Magazine a year ago by Messrs. G. S. Corstorphine and F. P. Mennell will be aware that there are large quantities of ore of lower grade in the mine in addition to the recorded reserves. Mr. Parsons agrees with Mr. Piper's view that large amounts of this ore are payable, but he appears to be keeping a higher average than Mr. Piper did. It is known also that there is little chance of finding any more ore of high grade. At the beginning of 1917 the reserve was estimated at 1,605,000 tons averaging 5·1 dwt. During the five months to May 31, 195,300 tons of lower-grade ore averaging 3·3 dwt. was developed. During 1916, the ore milled totalled 583,016 tons averaging 3·9 dwt. or 16s. 5d. per ton. The yield of gold was £446,860, or 15s. 2d. per ton. The cost was £251,025 or 8s. 7d. per ton, leaving a profit of £195,835 or 6s. 7d. per ton. The shareholders received £180,000, being at the rate of 30%. Mr. Parsons shows that during the first five months of 1917 the ore milled averaged 4·5 dwt., which is higher than the average for 1916 and higher than the figure mentioned in the directors' report as the standard for future output.

West Africa.—The figures for the monthly outputs of gold as given by the West African Chamber of Mines do not appear to be calculated by adding the individual returns of the mining companies. For instance, the official figures for July were £142,017 and those for June £114,489. By adding the individual returns, we get £125,974 for July and for June £123,003.

The Kaduna Syndicate is probably the most carefully directed company operating in Nigeria. Financial fireworks have been consistently absent, and the properties have not been over-capitalized. Arrangements are now being made for the practical extinction of the debentures, £8,715 being converted into 11,620 shares of 5s., being at the rate of 15s. per share, an exchange favourable to both debenture holders and the company. The directors have been fortunate in their engineers, first Mr. F. W. Armstrong, and now Mr. J. E. Snelus.

Australasia.—The labour situation continues critical. Owing to the strike of miners in New South Wales the government has taken possession of the mines and has called for volunteers. The railway strike in Queensland has been settled, and the wages question referred to arbitration.

The delivery in this country of the Mount Morgan report for the year ended May 31 last has been delayed, so we have to depend on the cable summary. The ore mined was 327,667 tons from Mount Morgan and 41,452 tons of fluxing ore from Many Peaks. The total was 57,938 tons lower than the previous year, owing largely to strikes. At the concentrator 141,430 tons of low-grade ore was treated for a yield of 42,197 tons of concentrate. The smelter treated 185,713 tons of Mount Morgan ore, 36,315 tons of concentrate, 51,801 tons of Many Peaks ore, and 1,236 tons of sundries. The yield was 8,042 tons of copper and 98,950 oz. of gold. The total revenue was £1,301,377 and the expenditure £992,172. The dividends absorbed £250,000, being at the rate of 25%.

The half-yearly report of the Hampden Cloncurry for the period ended February 28 contains mention of several interesting developments. In the Hampden mine itself the primary ore-body containing chalcopyrite has been found in the 500 ft. level from No. 3 shaft. This favourable condition has induced the directors to acquire additional property on the same line of lode, and shaft-sinking has already been commenced. At the Pindora promising results are being obtained on the 400 ft. level. On the 320 ft. level at the Macgregor the ore averages 10 to 14%. The total reserve at the various mines is estimated at 284,200 tons averaging 7½% copper. During the half-year the smelter treated 46,443 tons of ore and copper-bearing flux for a yield of blister copper containing 3,102 tons of copper, 1,028 oz. gold, and 23,418 oz. silver. The output was 604 tons less than during the previous half-year, the fall being caused by a breakdown of the power-plant. The income for the half-year was £263,647 and the profit, after allowance for depreciation, was £46,657. By drawing on the equalization reserve, it was possible to distribute £70,000 as dividend.

The South Kalgurli Consolidated continues to make small profits in spite of development disclosing no new ore-shoots. As Mr. John Morgan, the consulting engineer, says, the main ore-bodies yield ore by careful search long after they are supposed to be nearing depletion. Labour shortage has prevented progress with development on the 1,800 ft. level at a point where the diamond-drill had given favourable indications. The ore reserve is estimated at 133,220 tons averaging $5\frac{3}{4}$ dwt., a fall of 21,000 tons and 0·4 dwt. as compared with the figures a year ago. In addition the estimate includes 88,115 tons of probable ore averaging $5\frac{1}{2}$ dwt. During the year ended March 31, 110,333 tons of ore gave a yield of gold worth £125,550, and £3,125 was distributed as dividend, being at the rate of $2\frac{1}{2}$ per cent.

Malaya.—The Trong Tin Co. is an Australian company operating in the Taiping district of Perak with a bucket-dredge designed and built in Australia. Some particulars were given by Mr. H. D. Griffiths in his articles on Bucket-Dredging. The report of the company for the six months ended February 28 has arrived in this country. During this time, the dredge worked 3,506 hours, and treated 464,152 cubic yards of material, of which 127,042 yards was old tailing. The yield of tin concentrate was 202·6 tons, selling for £21,227. During the whole 12 months ended February 28, the amount treated was 863,893 yd. and the output 344 tons. The first dividend was paid in June, 1916, and three more have since been paid, each absorbing £3,300 or 1s. per share. The yield per yard during the half-year was 0·97 lb., and during the year 0·89 lb. Since then the yields per yard for March, April, and May of this year have been 0·85, 0·84, and 0·78 lb. respectively. During the half-year referred to, the loss per yard was estimated at 0·14 lb. The manager, Mr. H. G. Price, says that the deposit is ideal for dredging, the overburden being a sandy loam, and the tin ground a free gravel, with no stones or boulders, lying on an even bottom of soft decomposed granite easily dug by the buckets.

Cornwall.—Outlines of the half-yearly reports of some of the Cornish tin mines are given elsewhere in this issue. We note with regret that the campaign with the diamond-drill at Dolcoath has not so far given any beneficial result. Labour shortage has interfered with development, but at one point a useful supply of ore has been disclosed. The Tincroft mine has had a comparatively good half-year, and the manager is able to report encouraging results of exploratory work at several points. The directors have decided to distribute a dividend of 6d. per 5s. priority share, of which 38,607 are issued, the amount involved being £965. At the same time the remaining unissued 5s. priority shares, 11,393, are being offered for subscription pro rata at 10s. each, a course to which the large shareholders are agreeable. The income has been greatly augmented recently by the rise in the price of white arsenic, which now stands at £110 per ton, as compared with £30 a year ago and £13 before the war.

Though the diamond-drill has given no results at Dolcoath, it has proved efficacious at Geevor. Here the drill has been employed on the 5th level of North Pig lode to search for a parallel lode which had not been worked below the 3rd level. The lode was intersected at a distance of 118 ft. and a cross-cut is now being driven. It is interesting to record that South Crofty is also to try the diamond-drill for locating the extension of the Rogers lode. Exploration has so far been conducted by cross-cut, without definite result. There is geological evidence that the Rogers lode passes into South Crofty from East Pool, but it must be remembered that a lode is not the same thing as an ore-body or ore-shoot.

The Cornwall Tailings Company has been able to continue work owing to the high price of tin. There is still 400,000 tons remaining on the old dumps, but most of it is of too low a grade for treatment even at present prices. Moreover the working cost continues to advance. From the point of view of tin dressing, this has been one of the most interesting ventures of recent years, and the average recovery of 30% of the tin content indicates the present limits of efficiency of fine sand and slime machines. We often wish Mr. Arthur Richards would publish some of his logs.

Canada.—Our correspondent sends us a news letter from British Columbia reviewing the results of the cessation of strikes in the coal-mining district of Crow's Nest. Metalliferous mining was seriously threatened by the strike, for supplies of coal and coke were unobtainable and work at the smelters at Trail, Grand Forks, and Greenwood was restricted or suspended.

United States.—Official statements indicate that the consumption of petroleum and its products is at present greater than the production. The output of crude oil is at the rate of about 300 million barrels per year, and the consumption at the rate of 335 million. The amount of oil in storage is about half a year's supply. The rapid development of the motor car is largely responsible for present conditions. From 1910 to 1917 the number of cars in the United States has risen from 400,000 to 4,000,000, the latter requiring 40 million barrels of petrol per year. It is more difficult now to replace exhausted wells by new ones, and the country's output is decreasing. The entry of the United States into the war calls for greater quantities of oil. The government is taking drastic steps to control consumption on the part of the public.

The production of copper from the principal mines and smelters of North and South America during the first half of 1917 was estimated at 484,700 long tons. The miners' strikes which started in June are having a serious effect on the output, Arizona, Montana, and Alaska suffering equally.

The production of zinc in the United States during the first half of 1917 is estimated by the Geological Survey authorities at 364,000 short tons, as compared with 351,000 tons during the last half of 1916. Stocks on hand at June 30 were estimated at 33,000 tons, as compared with 17,000 tons on January 1. These figures show that the supply has caught up with the demand.

The United States Government has taken steps to control the export of gold, particularly to Spain, Mexico, and Japan, and in future all exports will require a special licence.

Mexico.—The Santa Gertrudis is at present in a far more favourable position than it has been for the last two or three years. The quarterly report for the period ended June 30 shows that during this time 85,705 dry short tons of ore was treated, for a yield of bullion worth £144,467. The working cost absorbed £120,772, and £598 was spent in equipment, leaving an estimated profit at the mine of £23,097. Unfortunately the rise in the cost of supplies and labour, and also in the taxes, more than offset the increased price of the metal. The mill worked at an average of 86·5% of the capacity. It was 100% in May, and the same maximum was expected in July; these conditions are governed mainly by the supply of cyanide. Development is well maintained. On the 16th level an exploratory cross-cut has intersected a new vein of a promising nature.

The report for 1916 of the Buena Tierra company, belonging to the Exploration Co. group, and owning a silver-lead property in Chihuahua, shows that operations were suspended in January of that year. The mine has since then been kept in good condition and a few improvements have been made in the plant.

Central America.—Mr. Charles Butters has long been engaged in gold mining in Salvador. His first mine was at Santa Rosa, and it was sold in 1899 to an English company called the Butters Salvador Co. The company was re-registered in Canada in 1912. Handsome profits were made over a considerable number of years, but the mine is now reaching its end, and it has been deemed advisable to go into voluntary liquidation. Among the assets is an interest in a small but profitable new property in Nicaragua. Mr. Butters' other Salvador venture is the Divisadero, which is doing well, and is noted as the centre of much good metallurgical work.

China.—Though the event happened several months ago, the news has not been generally circulated in this country that the Standard Oil Company of America has abandoned its ventures in Northern China. When the agreement between the company and the Chinese government was signed in 1914, a geological examination was made in the neighbourhood of Cheng-teh-fu, in Chi-li province, but the opinion of the experts was adverse. Subsequently attention was turned to Yen-chang in Shen-si province and extensive drilling operations were conducted. Though seven wells were drilled to a depth of 3,000 ft., very little oil was found, and a year or so ago the work was suspended. Negotiations were continued for some time between the company and the government, with objects not made public, but finally the matter was definitely abandoned by the Standard Oil people. The results obtained in Shen-si by the company appear to be at variance with local experience, for oil had been obtained in marketable quantities, and the government is still keen to carry on the work. Probably the truth is that the flows are not big enough to interest Standard Oil.

The Pekin Syndicate, which operates coal mines in the province of Ho-nan, had the same experience as regards difficulty of marketing as the Chinese Engineering & Mining Co., working in Chi-li. In each case the properties are one of a group of coal mines, the others being controlled by local owners. It was only natural to find that difficulties, from both official and trading sources, were put in their way. Eventually amicable agreements for the pooling of outputs were arranged. The Pekin Syndicate and the local owners of adjoining mines formed the Fu-chung Corporation, under government auspices, to regulate the output and to become sole selling agent. The Syndicate has this month issued a short report which shows that the friendly feeling between the Chinese and the foreigners is growing, and that the output and profits are expanding. The chairman of the Syndicate, Mr. T. A. Barson, has been in China since January, and intends to stay there some time yet.

MINING METHODS AT ASHANTI.

By H. I. JOHNSTON.

The mining of the famous Obuasi Shoot is rendered difficult by the fact that the ore, a brecciated graphitic schist, is in places so friable as to be almost a loose rubble and is separated from the wall-rock by wide selvedges of similarly loose material.

THE issue of the Magazine for May 1916 contained an article by Mr. W. R. Feldtmann describing the property of the Ashanti Goldfields Corporation. In the following notes the methods of mining the famous Obuasi shoot are given in detail.

THE ORE-BODY.—By way of preface a short description of the ore deposit in question may be of interest, and will help to make it clear why special care in mining is required in order to avoid danger to life and limb and loss of valuable ore. The Obuasi shoot occurs in disturbed ground, close to the intersection of two fissure planes, namely, the main Ashanti fissure, striking N. 30° E. with a south-easterly dip of 76°, and the Obuasi fissure striking N. 55° E. with a north-westerly dip of 65°. The shoot pitches N. 40° E. at an angle of, roughly, 45°, coinciding in direction and pitch with the trace of the two planes. In the upper levels the shoot is entirely within the plane of the Obuasi fissure, with which it corresponds in strike and dip (as distinct from pitch), but from No. 10 Level downward it commences to overlap the line of intersection and in its south-westerly part approximates the strike of the Ashanti fissure and assumes a steeper dip than above. The normal fissure-filling, or vein formation, is a brecciated graphitic schist, in places so friable as to be almost a loose rubble and, when waterlogged, tending to run as a liquid mud. This formation is wider than the ore-shoot at the latter's widest point, so that there is invariably a selvedge of from a foot to many feet in width of very heavy loose ground between the ore and the wall-rock proper, the latter being a fairly firm phyllite schist. The ore is white or grey quartz which, owing to the inclusion of parallel streaks of graphitic material, has generally a banded structure. In length along its strike the shoot measures from 300 to 700 ft. In thickness it varies from a few inches at the extremities to as much as 26 ft. in places. It has been worked out from the outcrop on the hill tops to No. 3 Level in Ashanti mine, or for a depth vertically of 600 ft., and is now being worked down to No. 17 Level, 1,600 ft. below the Main Shaft collar, or to a total vertical depth below the outcrop of 2,000 ft. Measured along the pitch line the total length of shoot worked and opened out down to No. 17 Level is 3,200 ft. It was not, however, a continuous deposit for the whole of this length as, in the upper levels, it consisted of detached lenticular ore-bodies. From No. 3 Level downward it has been continuous, except for an impoverished and pinched stretch between Nos. 6 and 8 Levels.

The difficulties encountered in developing and mining the ore are caused in part by the weakness of the containing formation, in part by the irregular, but, on the whole, considerable width of the quartz, and, in part, by the flat pitch of the shoot, in consequence of which the north-easterly portion forms a wedge with its thin end uppermost and which "lets go" from the soft formation on slight provocation.

DEVELOPING THE SHOOT.—Some years ago, when it was found that the upkeep of the main levels on the reef was likely to prove exceedingly costly owing to the necessity of close-timbering the heavy ground and to the relatively short life of the native timber—generally not more than twelve months—a system was introduced consisting of developing by lateral drives in comparatively solid and settled country, with frequent cross-cuts to and through the reef. This system has been consistently maintained since, at all levels from No. 8 downwards. Although it entails a considerable amount of dead work, it has justified itself handsomely by obviating much costly timbering and trouble with crushing of levels. The method of development in use is indicated in the sketches, Fig 1. The plan shows the reef at a point where it is 20 ft. wide. It is assumed to have been cut by the main cross-cut from the shaft (not shown). A lateral drive, or "side-tie," is first driven, parallel to the reef in hanging-wall country, so as to leave 15 ft. of ground between the vein formation and the drive. As the "side-tie" progresses, cross-cuts are driven to and through the reef at intervals of 25 ft. By careful measuring and sampling of the reef in the cross-cuts a reliable estimate is obtained of the value of the block being developed. A stope drive is next driven on the foot-wall side of the reef, in such wise that the bottom of the stope drive is about 4 ft. above the top of the cross-cuts, with which it is connected by means of short rises. These serve ultimately as box-holes for ore chutes.

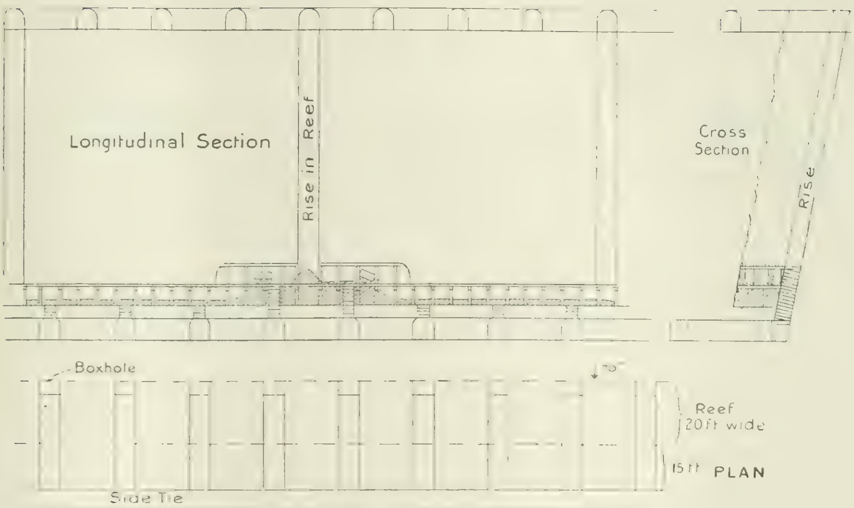


FIG. 1. SKETCHES SHOWING METHOD OF DEVELOPMENT.

Main rises for ventilation and to act as filling-passes are next put-up on the foot-wall of the reef at 100 ft. intervals, as shown in the sections. When these operations have been completed the block is ready for ore extraction.

ORE EXTRACTION.—The stope drive is stripped to the full width of the reef, 4 ft. of arch being left unbroken over the cross-cuts, and is secured by setts or props, according to the necessities of the case. The stripping is carried out by machine boring where the ground is particularly hard, but, in general, the shock of firing machine holes in the stopes, where there is so much "tender" ground about, is not considered desirable. When the full width of reef has been extracted from the stope drive and the latter has been secured, the block is ready for the next lift to be started. Successive lifts of 7 ft. in height are mined to the full width of the ore, as shown in the sections, these lifts or stopes being started at a main rise and carried through to the next one. While it would thus be theoretically possible to have two working faces advancing from each main rise, it is found expedient in practice to limit the number to at most four faces for the whole length of the shoot at any one horizon, the limiting factors which come into consideration being the obtaining and tramming of waste for filling and the trucking of the ore. As the stope faces are only as long as the reef is wide, and timbering has generally got to follow closely, ore-breaking is necessarily a somewhat slow process. As against that, however, stoping is proceeding at a number of horizons simultaneously, so that a monthly tally of over 7,000 tons is obtained from the Obuasi shoot.

As the face of a stope advances along the shoot the ore-passes to the cross-cuts are cribbed up to the level of the top of the previous stope in preparation for filling the same. The passes are constructed either in two compartments, of which one forms a ladder-way, or a single compartment for ore only. The cribbing for the passes is cut out of native timber 8 to 6 in. diameter, and the ore-pass compartment, or the single compartment pass, measures 4 by 4 ft. lined with an inside cribbing which reduces it to 2 ft. 6 in. square. The small timber used for cribbing poles grows at such a rate in the tropics that it is very inferior and soft, but when the lining cribbing wears out it is removed and renewed without any danger of running the filling which is held in place by the 4 by 4 ft. cribbing. In order to facilitate such repairs, the 2 ft. 6 in. cribbing is supported by bearers of 6 by 4 in. sawn timber carried on the 4 by 4 ft. cribbing at intervals of 6 ft.

The filling to replace each lift stoped follows on about 12 ft. behind the face of the next stope above, the waste rock for it being trammed along the levels in one-ton trucks and tipped down the main rises. The first of it is levelled by shovel boys for 15 or 20 ft. each side of the rise, after which 14 lb. rails are laid and the filling is conveyed along the stopes in small trucks holding 6½ cubic feet. (See Fig. 2). These filling trucks are made of native timber and can be easily taken to pieces and repaired in the stope, 1 in. plank and 6 by 4 in. tim-

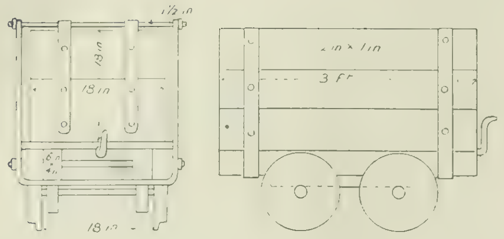


FIG. 2. THE TRUCKS EMPLOYED.

ber being all that is required, as shown in the sketch.

The bulk of the stope timber is buried in the filling, but where the reef is sufficiently solid to be carried on props instead of setts, these props are pulled out of the filling by means of a sling chain and 9 ft. lever. This operation takes from 15 to 30 minutes, with six natives. (See Fig. 3). The props, which are put in with the small end down, vary in size from 12 to 17 in., and can be used three or four times.

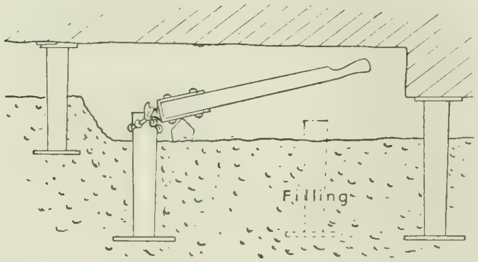


FIG. 3. WITHDRAWING PROPS.

Waste rock for stope-filling is obtained underground from various sources. In the top levels of the mine, for instance, a considerable amount of driving and prospecting was done with the object of locating the ends of known ore lenses and of prospecting for new ones. All the rock from these exploratory drives and cross-cuts has been used to fill stopes on the levels below. Then a relatively large and cheap supply of filling is obtained by stripping the sides and backs of old development drives and cross-cuts in solid country. Such stripping is done by native contractors with machine drills, one contractor having charge of two drills. Each machine is run by three boys, one "driver," one "spanner-boy," and one "pass-drill." One blast-boy does the blasting on two levels. Development rock from the sinking of the Main Shaft and from the bottom level cross-cuts, except when these are in ore, is also used as filling. It is hoisted to and trammed along the levels where it is required in one-ton ore trucks.

Occasionally patches of reef are encountered which are so friable and full of graphite seams that, notwithstanding all precautions, a run may occur. In several instances the reef has run for a distance of 25 ft. from the filling, and in such cases the fallen reef has been re-

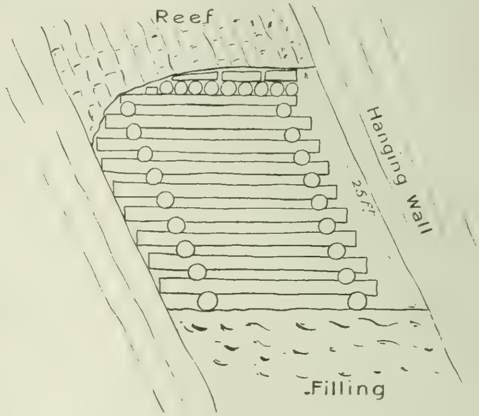


FIG. 4. TIMBER PACK, LEAVING ROOM TO PASS ON HANGING-WALL SIDE.

moved and a timber "pack" put in as shown in Fig. 4, leaving room to pass on the hanging-wall side. The timbers are 10 ft. long by 10 in. diameter and are joggled as shown. In the case of a more extensive run, spiling is resorted to, a breast of 4 ft. wide being spiled through at a time, followed by another breast of 4 ft. The fallen reef is thus recovered and replaced by timber and filling.

Petroleum in Cuba.—The first well to produce petroleum in commercial quantities in Cuba is the No. 5 belonging to the Union Oil Co. of Havana. It is 1,005 ft. deep, and, by the help of dynamite, the flow has been brought up to 150 barrels per day. The geology of the district has not been thoroughly investigated, but it is stated that the oil is found near the contact of a serpentine belt with sand and limestone strata of assumed Cretaceous age. Oil seepages have been noted at different points along the line of contact, as also are numerous asphalt deposits. The Union Oil Co. has been drilling for over two years, and struck oil first, but in small quantities, eighteen months ago. Another well, 200 ft. from No. 5, is yielding 25 barrels per day by pumping. As it is only 550 ft. deep, the results so far obtained are considered promising. The properties are about 13 miles from Havana.

ELECTRIC WINDING FOR MINES

By W. R. EVANS, B.Sc. (Eng.)

During the last few years electric power problems have been rapidly solved. At the present time this method of driving winding engines is attended with greater safety than the older types of plant. The author has written two articles discussing modern systems of electric winding.

ADVANTAGES OF ELECTRIC WINDING.—In recent years electricity has found a wide field of application in the mining industry, but in no instance has its adoption proved more interesting and advantageous than in the operation of winding. The winding problem, by reason of its intermittent and fluctuating character, and its important influence on the output of the mine, merits, perhaps, more consideration than any other process in the mining industry to which electricity can be applied. The characteristics of the electric drive are well known and appreciated. Safety, reliability, regularity of drive, control, and economy, are the main factors which enter into consideration of the relative merits of various types of winding gear, and it may be said that on all points results are favourable to the electric drive. The question of first cost, or cost of conversion from steam or air to electric drive, is an open one, as conditions in various mines vary so considerably. The operation of winding is so linked up with other operations in mining that it is only by a careful analysis of the problem in hand that a basis can be found for comparing first costs. Even then it is essential that this item be considered side by side with running costs in order to get at the true significance of initial cost. It is thus extremely difficult to arrive at a hard and fast rule with regard to the relative initial cost of various types of drive, and each case must be carefully considered in the light of prevailing conditions. The capital outlay on an electric winder depends primarily on the system adopted, which in turn is governed by the conditions under which power is available.

The marked improvement in large generating units in recent years, coupled with the fact that several winding plants may be operated from the same supply, has more than justified the double transformation of energy from fuel. In the coal-mining industry there is now a greater demand for slack coal outside the mine than hitherto, on account of improved methods in firing boilers, and also the production of patent-fuel. The uneconomical generation and consumption of steam cannot therefore be tolerated to the same extent as in earlier days when slack coal had little or no market value. This means that the over-all efficiency of the winding plant, reckoned from the coal to the useful shaft output, has to be increased, and it is here that electric winding offers special advantages.

The widely fluctuating character of the load, and the inherent low load-factor, provide the most unfavourable conditions for efficient production of steam with a battery feeding steam winders, resulting in a relatively high fuel consumption per shaft-horse-power-hour. Condensation and leakage losses which inevitably occur during the long periods of rest represent an appreciable fuel consumption. These conditions which affect all round efficiency so badly are much more favourably met by the electric winder. The latter lends itself easily to a system of load balancing, such as the accelerating and retarding of a flywheel, or the charge and discharge of a buffer battery. A balanced electric winder may be designed to work with almost constant input from the supply mains during continuous winding, and may be cut off from the supply during long periods of rest. Assuming in the first instance that the mine is equipped with its own generating station which supplies a fairly constant load to pumps, fans, etc., the increased output of steam called for when winding is in progress is a smaller item than when steam winders are fed directly from the boilers. This advantage is enhanced when two or more winders are supplied from the same generating station, as the overlapping of the load cycles tends to a more constant demand on the supply mains. This, of course, would be true to some extent with steam-winders, but the number of engines which can be economically fed from the same battery of boilers is limited by piping arrangements. It is possible, in many mine installations, to arrange operations so that pump and other loads may come on when winding operations are lightest, in which case the capital outlay on increased generating plant necessary for winding purposes becomes a minimum. At the same time this condition tends to a lower generating cost per unit by increasing the load factor on the generating plant.

If, on the other hand, power is purchased from a supply authority, the levelling-out feature of the balanced electric winder warrants an exceedingly favourable tariff which is one of the main factors in the running costs. Many power-supply companies base their charges on a combined maximum demand and flat rate, the period over which the maximum demand is computed varying with circumstances, as also the ratio of the rates. Since the maximum demand period taken largely exceeds the time of one complete wind, it may easily happen that the maximum demand units consumed are greater when a balancer is installed. However, since winding peaks are distinctly felt in stations even of large capacity, it is a decided advantage to the supply authority to minimize these peaks as far as possible, which may result in producing cheaper rates to the consumer.

Uniformity of drive is a much appreciated feature of the electric motor. The torque at the periphery of the rotor or armature is the same for any angular position during a revolution, by reason of the distribution of the windings. Any vibration or swinging of the winding ropes due to a periodically varying torque is thus avoided, resulting in a longer lease of life for the ropes. Each cylinder in a reciprocating winder of the twin type has to be designed to hold the maximum load since there are two crank positions per revolution in which the turning moment per cylinder is zero. With the cyclical variation of the torque of a pair of cylinders, swinging of the rope is unavoidable, though the effect may be damped to some extent by the inertia of the moving parts of the system.

THREE-PHASE WINDER. — By far the greatest number of electric winding installations operate off a 3-phase alternating current system of supply, and differ only in methods of control and balancing. Two-phase supply systems are not uncommon, and the characteristics of two-phase motors differ very little from those of the three-phase type. Electric winding, however, is seldom done off a single-phase supply, owing to difficulties experienced with the single-phase induction motor with regard to starting and control, and it is very improbable that any serious attempt will be made to utilize this type of machine for the direct-driving of winding engines. Although the single-phase commutator motor possesses the necessary speed-torque features for direct drive, its application to large installations has been very limited owing to manufacturing difficulties.

The first type of winder to be considered is that in which the driving power of a three-phase induction motor is applied to the winding drum, either directly or through gearing. The induction motor is essentially a constant speed machine, the speed drop between no load and full load varying from about 1% in large machines to about 5% in small machines. This approximately constant speed is dependent on a constant supply frequency, and no external resistance in series with the rotor

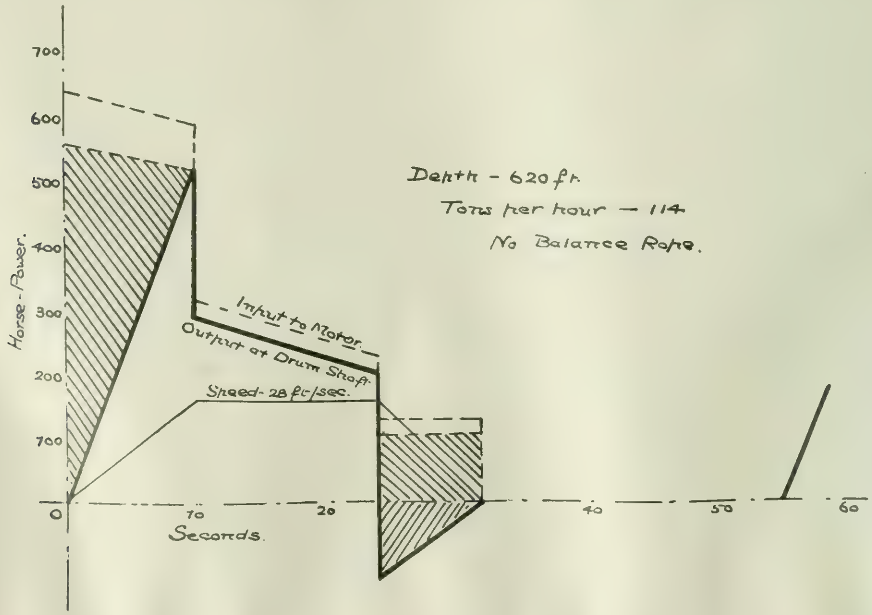


FIG. 1. TYPICAL WINDING DIAGRAM.

windings. By introducing a variable resistance into the secondary the speed can be varied from the maximum to a crawling speed. The electrical input to the stator remains constant, if the torque is constant, over the whole speed range. Neglecting the losses which occur in the rotor itself the difference between the electrical equivalent of the output at speeds below normal, and the input to stator, is wasted as heat in the external resistance, which means that for a given torque the maximum efficiency occurs at the highest speed. Moreover, the efficiency is almost directly proportional to the speed, neglecting of course the increased losses in the rotor core at speeds below normal.

RATING OF MOTOR.—Fig. 1 shows a typical load cycle for a winding engine designed to lift 114 tons per hour from a depth of 620 ft. with a plain cylindrical drum, no balance ropes being fitted. The upper curve shows the input to the motor when working to the cycle. The torque during each of the three distinct periods is not constant but decreasing, owing to the decreasing out of balance rope as the wind progresses.

The output of an electrical machine is, among other considerations, limited by its heating. Consequently the size of motor required for the satisfactory operation of the load diagram will depend, in the first instance, on the heating effect of the diagram. In this case the heating value of the diagram is 260 h.p. This means that the temperature rise of a normally rated motor of 260 h.p., when working continuously to this load cycle, would be the same as if the motor were run continuously at its normal rating. The question of temperature rise is an important one especially in dealing with plant at high altitudes as is the case on the Rand. The rarer atmosphere provides greater difficulties for the dissipation of heat.

Modern induction motors are capable of exerting an overload torque up to two, or two and a half times normal torque; and the normal rating of the motor must be chosen so that the accelerating torque of the diagram comes within the limit. Unless the load cycle is of a very unusual form the size of motor as determined from heating consideration will be sufficient to provide the necessary torque during acceleration. In Fig. 1 the shaded areas represent the power lost in the controller, and since this passes through the motor it has to be taken into account when arriving at the size of the motor.

The retardation period offers three alternatives. The load may be allowed to coast to bank under the action of friction and gravity, in which case the motor may be entirely cut off from the supply. Secondly, the driving torque may be gradually reduced from that required during the full-speed interval, and the system brought to rest by the application of the mechanical brake. And thirdly, the system may be brought to rest by reversing the current on the motor, which will then exert a torque against the momentum of the moving elements. The choice of one of these three alternatives depends on the time which can be allowed for the retardation period, a factor of importance in deciding the output of the shaft.

The efficiency obtainable with high-class machine-cut double helical gearing is in the neighbourhood of 95 to 98%. This enables the cheaper moderate-speed motor to be geared to the low-speed drum with little or no loss in efficiency, at the same time reducing first cost and providing a motor with much better power-factor characteristics. This latter point is of advantage when current supply is taken under power-factor restrictions.

CONTROL.—The method of control with this type of winder has the advantage of simplicity if not of economy. This fact, as well as low initial cost, has led to the wide adoption of this type of winder in the mines of South Africa where peak loads on the supply are of less concern than in this country. Although the flexibility of this method of control is sufficient to meet the requirements of almost all winding problems, it is not so sensitive and economical in its application as the Ward Leonard system. As previously mentioned the electrical input to the motor during the acceleration and retardation periods is almost constant over each period, with constant torque, and the surplus energy over that required by the cycle appears as heat in the controller resistance. This has an appreciable effect on the efficiency reckoned over the cycle, the extent of which naturally depends on the form of the load diagram.

For motors up to about 150 to 200 h.p. the drum-type controller with metallic grid resistance is usually preferred. With larger motors the rotor current to be dealt with is comparatively heavy, and with drum-type controllers results in excessive deterioration of contacts. The liquid controller is much better adapted for motors of large output, combining low cost with low maintenance, and at the same time producing a continuous smooth acceleration. In large units it has also the advantage of occupying less space than the grid-type resistance. Arrangements have to be made to dissipate the large amount of heat produced, and this is more easily accomplished in the liquid-type controller, in which cooling is usually effected by circulating water through a series of immersed cooling worms. The resistance may be varied by moving the electrodes in the solution, or by altering the level of the solution with fixed electrodes. Figs. 2 and 3 show a liquid controller built by Messrs. Allen West & Co. Ltd., Brighton. This controller has the distinctive feature of automatically controlling the acceleration of the motor independently of the operator. The squirrel-cage motor *A* drives the pump *B* continuously as long as the controller is in use, supplying water from the bottom tank *C* to the float chamber *D*. By one motion, either forward or reverse, the operator closes first the stator switch *E*, and then the valve *F*. The water then rises in the float chamber *D*, thereby raising the float *G*, and lowering the electrodes *H*. The rate at which this can be done can obviously be adjusted by the gate valve *J*; the time occupied in starting may be varied from 10 to 40 seconds. At the end of the wind the valve *F* opens, and the water thus drains quickly from the float chamber to the tank below. The float overbalances the electrodes and raises them to the starting position. The same operation opens the stator switch *E*. An interlock *P* is provided to prevent the operator from again closing the switch unless the float is in the bottom position with all resistance in. From this it will be seen that a steady start, and absolutely smooth acceleration are obtained, and that it is out of the power of the operator to alter the rate of acceleration without resetting the gate valve *J*, assuming that the torque remains constant. The height to which the float can lift is controlled by means of a cam *K*, separately operated, which provides for braking operations at the end of the wind, as well as for a creeping speed necessary for rope inspection.

The electrolyte is circulated in the controller in the following way: The automatic rise of the heated liquid takes it through the moving electrodes *H* to the top of the baffle plates *L*. It then falls on either side of the plates between the cooling pipes *M* till it reaches the passages in the stationary electrodes *N*, and once again flows upward. The continuous circulation prevents the accumulation of hot liquid, steam, or gases when the electrode is in its lowest position.

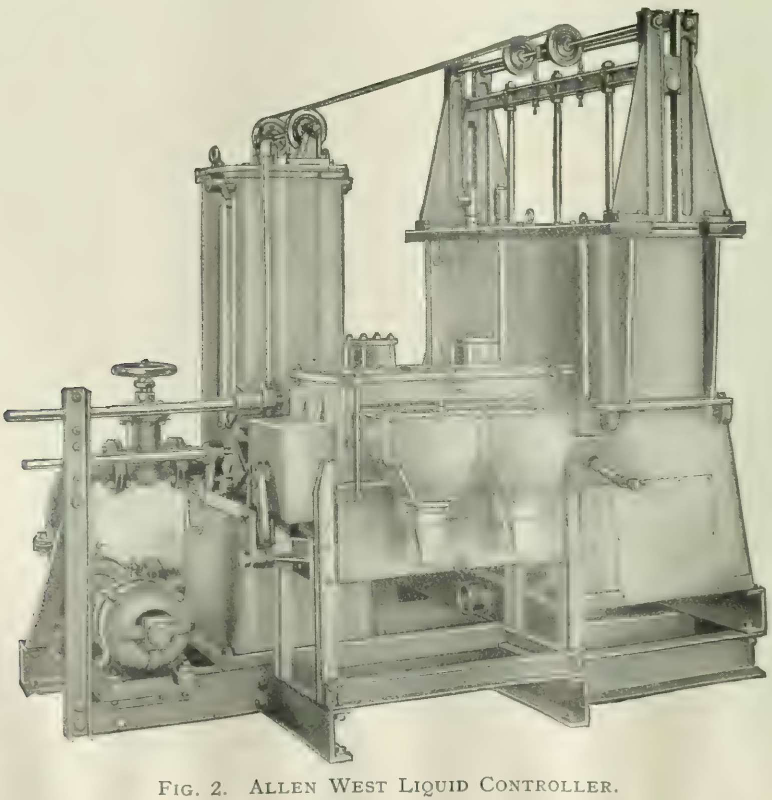


Fig. 2. Allen West Liquid Controller.

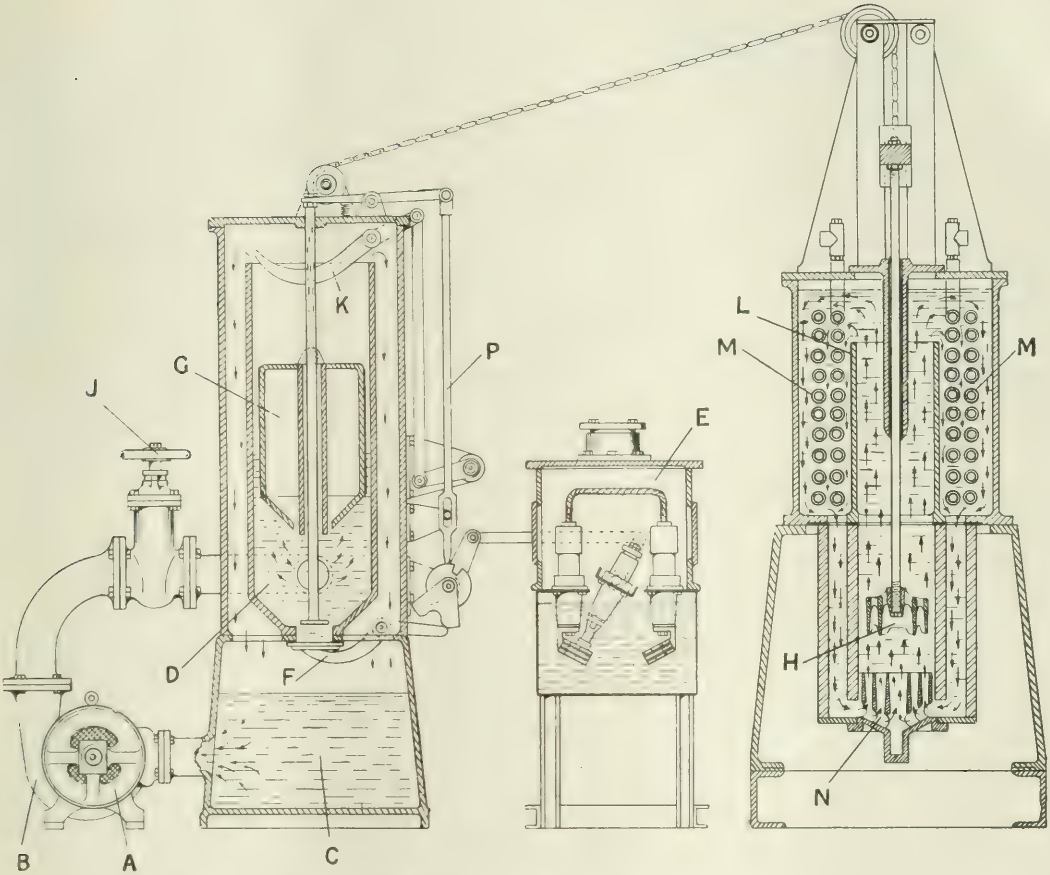


FIG. 3. VERTICAL SECTION OF ALLEN WEST LIQUID CONTROLLER.

On certain types of control apparatus buffer resistances are included between the reversing switch and the motor, with high tension supply, in order to minimize any disturbance in the supply line when switching on, and also to reduce the dielectric strain on the insulation of the motor windings.

BRAKING.—Mention has already been made of the braking feature of the induction motor when operated with reverse current. This feature may be employed to advantage when lowering an unbalanced load, or where rapid retardation is necessary to keep up the output of the shaft. By moving the controller lever along the section which would be used for hauling up the load, the latter will descend against the torque of the motor. The torque of the motor will increase as the speed increases until a counter-balance is effected, and the load will then descend at this speed which corresponds to this particular position of the controller. The speed is therefore under perfect control and may be varied by altering the position of the controller lever, the load being brought to rest by moving the lever farther towards the full speed position for ascending. Although this may be accomplished without the use of the mechanical brake it is well to make a slight application of the latter as an additional safeguard.

Power is taken from the mains in lowering by counter-torque of the motor as if the torque were employed positively in lifting, and this should be considered when providing for economical running. With the exception of the motor losses, the energy taken is transformed into heat in the controller resistance. The mechanical energy of the rotor in virtue of the descending load is converted into electrical energy in the rotor, the larger portion of which also appears in the controller resistance as heat. Heavy controllers are thus necessary when lowering of unbalanced loads is a frequent occurrence. By co-operation of the mechanical brake this expenditure of power may be reduced.

Lowering by counter-torque is of special advantage when heavy loads are lowered at reduced speed owing to the large reserve of braking power available. It is also useful in the smooth retardation necessary when stops have to be made at different levels in a vertical shaft. Strain and the resulting wear and tear on brake treads are naturally reduced.

If an induction motor, connected to its supply, be driven at a speed in the same direction, higher than its synchronous speed, it will operate as a generator and pump back energy into the line. This feature can be made use of when lowering an unbalanced load, and has the additional advantage of a braking action while converting the kinetic energy of the system into useful electrical energy in the line. To commence the descent the clutches are released, and the brake pressure gradually released until the load attains its normal speed of descent. The controller lever meanwhile is moved from the "off" position to the "full speed" position in the direction of the descending load. Further increase in speed causes the motor to run above synchronism, which owing to its generator action will now exert a counter-torque against the load. Energy is now being pumped back into the line in amount proportional to the excess of speed over synchronism. The speed is limited by the back torque of the motor, and in a properly designed system lowering a normal load, it should not exceed about 3 to 4% above synchronism. For retardation it is necessary to apply the mechanical brake sufficiently to keep the moving load well in hand. The controller lever may then be moved to the "off" position, and the load brought to rest by the brake, or if further movement is made, by combined counter-torque and brake.

This method of lowering an unbalanced load is particularly suitable for haulage gears in drifts whether main or auxiliary, but in vertical shafts it has one or two disadvantages. In the former the usual gradient met with is such as to allow much more freedom of control than is permissible in vertical shafts. The unbalanced load may, for a considerable portion of the trip, be allowed to descend without any appreciable braking, the rolling friction of the system being sufficient to prevent it attaining a dangerous speed. This condition enables the operator to throw over the lever to the counter-torque position without any danger of losing control. Regenerative control is thus well adapted for inclines of moderate gradients.

Since there is a definite space of time in which the controller lever can be moved to the counter-torque position, this method is not to be recommended with alternating current winders on vertical shafts. The motor exerts no torque when the lever is passed through the "off" position, and a heavy unbalanced load may jump to a dangerous speed in this short interval. It is only by skilful handling, and the judicious use of the mechanical brake, that this method can be applied with any degree of safety in vertical shafts dealing with heavy unbalanced loads.

SAFETY DEVICES.—It has been pointed out previously that electrically driven winding engines lend themselves to easy adaption of safety devices. In cases where men are raised or lowered in main coal or ore shafts it is absolutely necessary to provide winding gear which is thoroughly reliable, and efficiently protected against accident. The miner must be assured that his movement when descending a vertical shaft is under complete control. Electrical devices have entered so far into the problem of winding that it is now possible to provide electrically driven winders which are entirely automatic in action from loading to banking. Such a plant has been recently installed at the Inspiration mine, Arizona.

The interlocking of the electrical system with the mechanical brakes provides many interesting features, and enables the ordinary brake to be utilized as an emergency brake when conditions demand so. In winding operations generally the conditions which call for the application of the emergency brakes are: (1) Failure of current supply; (2) Over-load; (3) Over-speed; (4) Over-wind. With modern generating units and improved transmission systems, the first mentioned is of infrequent occurrence, but provision must be made to apply the emergency brakes in the event of supply failure when the cages are in motion. In this connection it may be mentioned that when electric winders are operated in conjunction with fly-wheel balancers, the fly-wheel is usually of sufficient size to supply enough energy to complete at least one trip in case of supply failure.

The emergency brake device usually employed consists of a solenoid with a weighted trip gear. Normally the solenoid is energized, and holds the trip mechanism so that the weight is in a position for descent. Immediately the current fails from any cause, the trip is released, allowing the weight to apply the brakes. Brakes operated by compressed air are arranged so that the weight is held in position by compressed air. Failure of current releases a valve, allowing the weight to descend. It is customary to provide the mechanism with a dash-pot to prevent too sudden application of the brake. The main circuit-breaker controlling the supply to the motor is equipped with over-load and no-volt release, the latter opening the breaker and the brake magnet circuit in the event of supply failure. The circuit-breaker lever is interlocked with the controller lever in such a way that the latter must be brought back to the "off" position before the breaker can be closed. The necessity of this is apparent, as when the supply fails during a trip, the controller is then in either of the running positions. The overload release automatically opens the supply when the winder is overloaded either by excessive loading of the cages or by some obstruction encountered during the trip. Overloading may also be produced by accelerating too rapidly.

Protection against overwind is closely connected with protection against overspeed. The synchronous speed of the motor is selected to correspond with the maximum permissible rope speed, and when raising an unbalanced load this speed cannot be exceeded. Not so, however, when an unbalanced load is being lowered. Through unskilful handling the motor may be deprived of its torque for a moment or so, and may result in the system attaining a dangerous speed. The question of protection from overwind is one which admits of wide variation of practice, and depends largely on the prevailing conditions. It is sometimes contended that with a system which is completely protected from overwind and overspeed, the operator is liable to indulge in a wide latitude of judgment when slowing up the wind. Frequent overwinding, on the other hand, apart from the risk of disaster, does not improve the winding plant in any way, and causes loss of time. Adequate protection from overspeed and overwind should be favourably considered for all vertical shafts, especially those dealing with large outputs at high speeds.

The induction motor winder is perhaps not so well off as the direct-current winder in its suitability for overwind protection. The main point to be achieved is that the speed when passing a predetermined level below the surface must be sufficiently reduced to enable it to be well under control when coming to bank, otherwise it would be impossible to bring the cage to rest between the banking level and the sheaves. This feature can be extended by introducing in between one or two extra points of limitation of speed, which will ensure a comparatively slow speed when reaching banking level.

Where a contactor-type grid controller is employed, this result is obtained by means of a limit-switch device geared to the drum or depth indicator, the device being arranged to operate the contactors when the cage passes predetermined levels in the shaft. The action is independent of speed and operates automatically during each wind, if the driver has not already sufficiently reduced the speed. It is therefore not applicable where unbalanced loads are lowered above synchronous speed, since the counter-torque of the motor acting as a generator is decreased by the introduction of resistance into the rotor circuit. It has a reversed effect on the speed of the descending load to that required.

An entirely different type of device has been used for some time which eliminates this disadvantage, and is moreover independent of the type of controller. It consists of a centrifugal governor of the ordinary type working in conjunction with a geared limit switch. The latter controls the no-volt release on the circuit breaker. It is so arranged that when the speed at a predetermined level in the shaft exceeds a certain value, the breaker is tripped, and at the same time the emergency brakes are applied. As an example of the range of operation of such a device, if we take the cycle shown in Fig. 1 it would be arranged to apply the emergency brakes if the speed is not reduced to 70% normal when passing the 60 ft. level, and, further, if the speed is not reduced to 30% normal when passing the 30 ft. level. The action of this device can be extended to produce the above result if the cages are inadvertently started in the wrong direction, or overwound. Also to safeguard against too rapid acceleration at the commencement of the wind, although this protection is seldom introduced since a too rapid acceleration would cause an overload on the motor, and would be taken care of by the overload release on the breaker.

With the controller shown in Figs. 2 and 3 acceleration is entirely automatic, and calls for no further protection. Limit switches are sometimes placed in the shaft or headgear, but the above method is preferable since it admits of easy inspection, and is not subjected to the same wear and tear as shaft appliances. In any type of electrical safety device it is best, as a further precaution for safety, to go for a design in which the action depends on the opening and not the closing of an electric circuit.

A notable overwind protection device has been developed and successfully applied to winding plants by the British Westinghouse Company. It consists of a small series direct-current generator which is chain-driven from the main motor shaft. A variable resistance which operates from the depth indicator is placed in series with the armature and with a relay. With a given speed the current will increase with decreasing resistance. The rheostat is so arranged with the depth indicator that the resistance is increased during acceleration, maintained constant during full speed, and then gradually reduced at a point when retardation should commence. The relay consists of a single-pole switch operated by a solenoid, the switch being arranged to control the action of the no-volt release on the circuit breaker. If retardation has not commenced at the proper instant, the excess current from the small generator releases the relay switch, thus tripping the main breaker and applying the emergency brakes. This result may take place through overspeed during the full-speed period, and also by too rapid acceleration. This device, therefore, not only controls the speed during retardation for the prevention of overwind but controls the speed to a large extent during the whole trip.

The usual equipment of the driver's platform consists of the controller lever, brake lever or pedal, emergency brake lever or pedal, depth indicator, and instrument pillar fitted with a voltmeter and ammeter. The latter is extremely valuable to the operator in indicating within reasonable limits the behaviour of the motor during the trip, and providing for economical manipulation of the controller.

(To be continued)

[In a second article the author will discuss winders operated by direct-current machines driven by alternating-current motors.— EDITOR].

INSTRUCTION FOR PROSPECTORS

By F. P. MENNELL, F.G.S., M.I.M.M.

The author gives an account of a short course of instruction for prospectors recently inaugurated in Rhodesia.

THE war is, of course, first, second, and third in importance among the topics of discussion even in a locality so remote from it as Matabeleland. There are, however, a number of subjects which may appear very remotely connected with military operations to which the war has given an added interest. Among these the decline of prospecting has for some time past come in for a lot of attention in Rhodesia, not only in mining circles, but also in the public press, since it has become apparent that Rhodesia must be prepared, not only to supply its own needs, but even to supplement home resources in the case of a number of mineral products.

In suggesting remedies for the undisputed fact that few new discoveries are being made, there has often been a tendency to overlook some of the most important factors of the situation. For instance, it is often forgotten that the war itself is largely responsible for the decrease of activity. No country has supplied a larger quota of volunteers for the front; indeed a return made as the result of a searching inquiry recently showed that there were no more than eighty men of military age in Bulawayo who could still be considered as possible recruits. It is not surprising therefore that few prospectors are still going about the country. The prospector who is under forty, or who can persuade anybody to believe he is, is about the first man to offer himself for active service, and it did not take long to drain the country of nearly all the younger and more able-bodied men. Practically all the men now available are a long way over forty or have either been rejected as unfit or returned invalided from the front. It is consequently all very well to propose heroic measures, such as state subsidies; it is quite another thing to find the men themselves. So far the only practical step which has been taken has been the giving of a short course of instruction at Bulawayo with a view to better equipping prospectors, or would-be prospectors, for their task. It was felt that a move in the direction of greater efficiency was more likely to be attended with good results than any other steps that could be taken. The course was given in June at the Rhodesia Museum on the initiative of the chairman, Mr. A. J. C. Molyneux, and was arranged on what are perhaps somewhat novel lines. It is for this reason that it has seemed that a few particulars regarding it might be of interest to readers of the Magazine.

The carrying out of the scheme was entirely dependent on the voluntary co-operation of all the available local geologists. The Museum assisted to the extent of advertising the course, and providing most of the apparatus and material required. The fee asked from those who attended—£1—was not expected to, nor did it in fact, cover more than a fraction of the total cost. Under Rhodesian conditions, that is to say, with very scattered mines, it was useless, if the real miner was to receive any benefit, to have evening classes, such as might be suited to centres like Johannesburg or Kalgoorlie, with a large mining population on the spot. The course was accordingly planned on lines originally suggested by myself, some six years ago, in an address to the Rhodesia Scientific Association. Lectures and practical work were arranged, to last from 9 a.m. to 5 p.m. daily for the period of a fortnight, the idea being that those attending should arrange to leave their work and spend that time in town. The instruction given was of a most comprehensive character, as will be seen from the annexed syllabus. Indeed, one may well anticipate the criticism that it was impossible to give useful instruction in so many subjects in so short a time. However, the programme was duly carried out, and as far as could be judged, we were justified by results in making it cover so much ground. It served at any rate to give those who attended an idea of what there was to be learnt, which was already something. Further it was often possible to set them on the right road toward acquiring the instruction where it was obviously impossible to impart it in the few days devoted to it.

SYLLABUS.

1. Determination of minerals (A. E. V. Zealley, A.R.C.S., F.G.S.).
   a. The classes of minerals.
   b. Composition of minerals.
   c. Hand tests.
   d. Blowpipe testing: (1) Introduction, (2) Flame colouration and fusibility, (3) Reactions with borax and other beads, (4) Reactions in closed and open tubes, (5) ditto with reagents, (6) Reactions on charcoal.
   e. Association of minerals.
2. Determination of rocks (H. B. Maufe, B.A., F.G.S.).
   a. Texture and composition.
   b. The classes of rocks.
   c. The natural history of rocks (weathering, metamorphism, differentiation, etc.).
3. How rocks occur in the field (A. J. C. Molyneux, F.G.S.).
   a. The origin, structure, and relations of sedimentary and igneous rocks.
   b. Faults and disturbances in rocks.
4. The Geology of Southern Rhodesia (A. J. C. Molyneux, F.G.S.).
   a. The geological formations.
   b. The distribution of the formations and their surface features.
5. Mineral Deposits (F. P. Mennell, F.G.S., M.I.M.M.).
   a. Classification of mineral deposits.
   b. Origin of mineral deposits.
   c. Distribution of ores.
   d. Distribution of values in ore-bodies.
   e. Dislocations of ore-bodies.
6. Prospecting (F. P. Mennell, F.G.S., M.I.M.M.).
   a. What to look for.
   b. Where to look.
   c. What constitutes a valuable prospect (including sampling, etc.).

Some of the subjects were dealt with very briefly. Thus parts 3 and 4 were the subject of only three short lectures and demonstrations in all. The bulk of the time was devoted to practical exercises in the testing of minerals, under the supervision of Mr. Zealley, of the Rhodesian Geological Survey. It was considered that this would be the most acceptable part of the course to those who attended it. However, it was gratifying to find that regret was expressed that it had not been possible to devote a greater amount of time to the more theoretical matters such as the origin and classification of rocks and ore deposits. The method of instruction adopted was a close imitation of that given at the Royal School of Mines, short lectures being followed by demonstrations on specimens or apparatus and by practical work carried out by the students themselves. Each person attending the course was required to bring a quarto note-book, one or both of the following books, "Prospecting for Minerals," by S. H. Cox, and the "Miner's Guide," by F. P. Mennell, and a set of apparatus for testing minerals by the blowpipe and other simple means, the supply of which had been arranged for with a local firm.

There are probably few mining centres, apart from those of large population, where it would be possible to carry out a course of instruction such as that outlined above by purely voluntary effort without a hitch. What is hoped here is that after the feasibility of the scheme has been thus demonstrated in actual practice, the Government may see its way to making a substantial grant in order to provide for somewhat similar classes being organized on a more extended scale, and established on a more permanent basis. Courses might then be arranged at different times of the year, and possibly at more than one centre, each subject having as much time devoted to it as was in this case possible to allow for the whole course.

LATERITE:
ITS ORIGIN, STRUCTURE, AND MINERALS.

By J. MORROW CAMPBELL, B.Sc., M.Inst.M.M., F.R.G.S.

(Continued from August issue, page 77).

In this section of the article the author discusses the Locus of Laterization and the Genesis of Laterite.

Chapter IV. The Locus of Laterization.

In the tropics and the sub-tropics we find mountains capped with laterite, hills of varying height surmounted by it, and valleys carpeted with it. The most casual observer will admit that laterite on the mountains is older than that on the hills, and that the valley laterite is younger still. Very soon we come to the conclusion that in a given district the altitude of any laterite bed above present vadose water-level is a measure of its age.

The oldest laterites in West Africa, lying about 5,000 ft. above sea-level on mountain tops, frequently show on their present surface a layer of detrital origin consisting of cemented fragments of quartz and other rocks very considerably water-worn. These boulders and gravels could only have reached their present position by being borne by water from higher levels. This material, having undergone laterization, must have been at rest for a prolonged period, and the only position in which it could remain thus undisturbed is a gentle slope or flat lower than at least some of the ground in the vicinity. It could not collect on a mountain top or find any but temporary lodgment on a steep slope. It follows therefore that when this old laterite was formed it occupied a position on comparatively flat ground.

When the surface of almost any considerable area of laterite is examined similar evidence of the detrital origin of some part of its superficial layer is so frequently found that we are justified in asserting laterite to form only on comparatively flat ground. Examine the valley laterite now in course of formation and we find the same holds true; it covers the flatter ground and stops where the slopes are steep; its surface too is practically always a cemented recent sediment.

This view was previously stated by the author.[31] Since then Mr. Arthur Holmes[32], writing of laterite in Mozambique, says: "It is found on gently undulating portions and never on steep slopes." Prof. Lacroix[33] says regarding French Guinea that laterization proceeds actively whenever the slope of the ground is so slight as to permit water to permeate it, and especially where such water may remain long in contact with the rocks. He also quotes the surface of diabase-covered plateaux and the almost horizontal bottoms of valleys as being favourable to the formation of laterite.

Does laterite form in the zone of non-saturation, that is, above water-level? M.M. Chautard and Lemoine[34] assert that analysis revealed the presence of uncombined alumina in rocks exposed to weathering for only a few years in railway cuttings on the Konakri-Niger Railway. Prof. Lacroix, aware of this assertion and with an open mind, examined the same rocks some years later, but, instead of finding an increased amount, he found no trace of free alumina. If the fresh rock surface of a railway cutting exposed for three years develops an appreciable amount of free alumina there should be no difficulty in finding the same compound in abundance on cliffs and boulders that have been exposed for centuries. Prof. Lacroix subjected such rocks that had been exposed to the weather—rain and flowing water—for long periods to both analysis and microscopic examination in order to find free alumina, but with uniformly negative results, and he says definitely that these agencies do not cause laterization. We have already proved the necessity of disregarding analytical work published by M. M. Chautard and Lemoine, so here again we must reject their results since they are in conflict with those of a very competent observer. The writer has examined the weathered diabase of Mts. Didi and Kalaba in French Guinea as well as a variety of exposed rocks in Ashanti, Katanga, Nigeria, &c., and in no case was free alumina found nor was there any indication of laterization revealed either by analysis or under the microscope.

Dr. Fermor[35] thinks that lateritic constituents might form on steep slopes above water-level and be removed by erosion, but offers no evidence. Rocks of many kinds exposed to every influence which above water-level pro-

[31] Trans. Inst. Min. Met. xix., p. 436.
[32] Op. Cit., p. 348.
[33] *Geol. Mag.* 1914, p. 531.
[34] C. R. de l' Ind. Miner., 1908.
[35] *Geol. Mag.* 1915, p. 77.

motes change have been carefully examined for lateritic constituents and none have been found. We are therefore justified in asserting that laterite does not form in the zone of non-saturation. Laterization is not a tropical form of weathering in the ordinary sense of the term; if it were efforts to obtain evidence of it would not have been futile. Lateritic material resists solution or removal in other ways by subaerial agencies much too strongly for all trace of it to be removed from places where it is not subject to erosion.

Does laterite form in the zone of permanent saturation? We find many rocks decomposed, kaolinized, altered in the tropics to a depth sometimes exceeding 100 ft. below water-level, changed in composition and appearance very greatly, but certainly not laterized.

The writer has had unusual facilities for observing the depth to which laterization extends with relation to water-level at all seasons of the year as well as in many parts of Africa and has never seen it extend below the minimum vadose water-level. Where laterization is going on lateritic constituents are found in the strata, no matter what their nature, until the above level is reached; a foot below it none are to be found. The fact that so few geologists have noted this important fact is proof of how little the process of laterization has been observed or studied in actual operation. Laterite does not form in the zone of permanent saturation. The writer has never seen it under water and there is no record of any other person having seen it forming in such a position. If it could form under water it would have been observed there, and there seems no reason why it could not attain a thickness of hundreds of feet.

There is now left only one zone, that of intermittent saturation, and it is there that laterite forms. The lower limit of every laterite bed in course of formation is the minimum vadose water-level. This, though it may approach horizontality, is usually a gentle slope. Laterite does not always form in the zone of intermittent saturation. If it did we should find beds of it vertically below one another with unaltered rock intervening; this never occurs. The determining factor is free access of atmospheric oxygen to the surface of the vadose water.

Laterization may not take place in the zone of intermittent saturation owing to the following causes: 1. The existence above it of a zone of non-saturation of considerable thickness which prevents access of oxygen. Having taken place it may be arrested by: 2, the retreat downward of vadose water below the laterite the increasing thickness of which ultimately excludes oxygen; 3, the sealing up of the surface of laterite by the formation of a skin which excludes air. This happens only when the maximum vadose water-level actually reaches the surface.

The depth of ground or of laterite necessary to prevent or arrest laterization varies with its porosity. As overlying laterite thickens the process becomes slower, and in most cases it appears that 20 to 30 ft. forms a barrier practically impassable to oxygen, and laterite ceases to form. This explains why laterite deposits never attain a great thickness.

The Locus of Laterization is the zone of intermittent saturation when that zone is so situated that atmospheric oxygen has comparatively free access to it.

Chapter V. The Genesis of Laterite.

1. Laterizable Material.—In studying a geological problem such as the formation of laterite of which an abundance of evidence is to be seen in many localities, the observer is naturally inclined to devote his attention to such examples as appear to him to be typical rather than to examining those younger beds which appear not to be typical and which at first may not be recognized as being genetically even in the same category. The literature of the subject gives us practically no record of observations made of the process in actual operation though it abounds in analyses, chemical equations, surface observations, and theories. With all due deference to the able geologists who have studied laterite in the past I must protest that this method is eminently unscientific. The only reliable guide as to the means whereby certain results were produced in the past is to discover how similar results are being produced to-day.

In the earlier stages of its genesis laterite is so variable in appearance and so different from the fully evolved rock that some criterion is necessary whereby a reliable decision may be reached as to whether material is lateritic or not.

The hydrates of iron, aluminium, and titanium (in the order of their abundance) are invariably present in laterite. Ferric and titanium hydrates are useless as criteria, for they are both found quite commonly in clays and other surface deposits that are certainly not lateritic. Uncombined aluminium hydroxide must be regarded as the characteristic constituent of lateritic material. The writer has used it systematically as his criterion. If its presence in a surface rock is not regarded as the criterion of what is lateritic we are absolutely without means to form a correct judgment. Apart from their occurrence in rocks of lateritic origin aluminium hydrates are found only rarely and in small quantities.

A prolonged correspondence took place a few years ago in the *Geological Magazine* regarding aluminium hydrate in laterite. It culminates in a letter from Mr. J. B. Scrivenor[36] in which he states that aluminium hydroxide (free) exists in all Malayan laterites, and that he finds it also in weathered granite, in kaolin, and in slate. In a further letter[37] he quotes an analysis of decomposed granite showing over 13% of free alumina and argues that, according to certain definitions, this should be called laterite. Many rocks in the early stages of laterization contain free alumina which must be regarded as lateritic in origin, because we know no natural agency which produces free aluminium hydrate at the surface except the process we call laterization. The presence of 13% of free alumina does not necessarily justify the name laterite being applied to a rock. This decomposed granite might develop into anything from a ferruginous to a bauxitic laterite depending upon the influences to which it is subjected later. In the meantime it is no longer granite; it is lateritic, but cannot yet be properly called laterite. This example is quoted because it illustrates very well not only difficulties of nomenclature but the puzzling nature of the material often encountered in studying the genesis of laterite.

Up to the present time no suggestion regarding the manner in which aluminium hydrates are formed has met with general acceptance.

Year after year more and more evidence is forthcoming from competent observers as to the composition of material underlying laterite and from which laterite is now forming. Ferriferous minerals have had their iron leached and, while the outlines of original crystals may remain, the rock has been bleached and consists essentially of hydrous silicate of alumina.

Certain definite conclusions have been reached and they are supported strongly by observations made by Prof. Lacroix[38] in his description of the laterization of nepheline syenite in Ile de Kassa (one of the Isles de Los, off Konakri, French Guinea). He says it breaks up into blocks. Decomposition proceeds inwards along the cracks. Sometimes in the centre of a block a spherical unaltered core remains. Around this is a friable layer, milk-white owing to removal of iron. Further out the material is more coherent and pink in colour; still further out it is red and on the outside it is dark reddish-brown and quite hard—laterite composed of ferric hydrate enclosing crystals of gibbsite. He remarks regarding these blocks that the centrifugal movement of the iron is quite remarkable. This conclusion involves a fallacy and is an excellent illustration of an error arising through the method of study mentioned in the opening statement in this chapter. It is quite evident that Prof. Lacroix considered the process of laterization to be either proceeding in the syenite at the time of his visit or that the process of alteration of the syenite and its laterization were contemporaneous.

Digression is necessary here in order to review Prof. Lacroix's views on laterization in general. He regards the process as taking place in two zones which he calls the "*zone de départ*" (leaching zone) and the "*zone de concretion.*" His *zone de départ* does not properly correspond to either the zone of intermittent saturation or that of permanent saturation, but refers rather to the band of rock underlying laterite proper which gradually merges into laterite above and into unaltered rock below. It is very variable in depth and bears no relation whatever to the present vadose water-level. He does not differentiate between live and dead laterite. This leaching zone cannot be regarded as having any real connection with laterization. It exists in the tropics in places so situated physically that laterite cannot form. A similar zone exists in temperate and cold climates above unaltered rock. It may be regarded as practically identical functionally with the zone of vadose water. Sometimes, however, in addition to the zone of permanent saturation it embraces part of the zone of intermittent saturation, in other cases it includes the whole of the latter and even part of the zone of non-saturation. This is the case at Fatoya[39] which place is well-known to the writer. There the laterite on the Mine Hill is situated high above maximum vadose water-level.

The alteration of a rock in the zone of permanent saturation and the production of laterite from the altered products of that rock are two distinct and separate processes, and the product of each process is quite stable above water-level. The *zone de départ* in relation to laterite has no *raison d'être*.

[36] *Geol. Mag.*, 1910, p. 336.
[37] Op. Cit., p. 384.
[38] Op. Cit., p. 227.

[39] Lacroix Op. Cit., p. 306.

The ferric hydrate observed by Prof. Lacroix in the laterite crust of the syenite block is not the result of oxidation of the ferrous iron that was removed from the interior of the block. The syenite had been in the zone of permanent saturation for ages where its iron, alkalies, etc., were being leached but, before its alteration was complete, while an unaltered core and a partly altered layer still remained, the zone of intermittent saturation reached it; the vadose water-level fell. The exterior of the block was then white, consisting of hydrous silicate of alumina more porous and softer than the milk-white semi-altered layer within. As soon as oxygen gained access lateritic constituents commenced to deposit in the pores. The vadose water current passes through these pores and the amount of deposit left varies of necessity with the porosity at first. None can reach the impermeable centre or the milk-white layer; enough reaches the next layers to colour them pink and red with ferric hydrate, whereas the more porous exterior becomes dark reddish brown. This iron is derived from the vadose water which had leached it out of a variety of rocks in the same drainage area. This cannot be described legitimately as centrifugal movement of the iron.

M.M. Chautard & Lemoine, as well as Prof. Lacroix, failed to understand why the diabase and laterite of French Guinea join one another abruptly. Writing in 1910 concerning the same diabase I attributed the phenomenon to the resistance that that rock offered to alteration. Later diabase was seen covered by many feet of altered rock and this in turn by laterite showing abundant outlines of crystals of the original rock; then I realized I was wrong. I next saw small basalt dykes in granite covered by laterite ending abruptly, the granite being completely and the basalt incompletely laterized. Granite is usually kaolinized for many feet below laterite when such overlies it. Why should granite be decomposed in one case and not in another? I found comparatively fresh and unlaterized gneiss in a detrital laterite. Why did it remain unaltered? I observed well laterized detrital deposits overlying a fresh water-worn granite surface, adhering to it, yet the granite showed no sign of either alteration or laterization. Dr. Falconer[40] cites a similar occurrence of detrital laterite adhering to a bare and unweathered surface of granite.

The only explanation of these occurrences is that when the zone of intermittent saturation sinks to the level of unaltered crystalline rocks they do not undergo laterization, and moreover they appear to suffer very little if any decomposition during the period of laterization. That unaltered crystalline rock cannot be laterized is in conformity with all my observations and explains many phenomena otherwise apparently inexplicable.

Crystalline rocks must be altered before they can be laterized. The product of alteration of ordinary crystalline rocks consists essentially of hydrous silicate of alumina with or without quartz. All hydrous silicate of alumina resulting from the alteration of crystalline rocks is normally porous and readily permeated by water. All tropical beds of sedimentary origin are porous. The only material I have seen undergoing laterization that might be argued to be non-porous is plastic clay in beds of sedimentary origin. Such beds in tropical Africa are invariably perforated by holes left by plant roots and burrowing animals. I have encountered many such beds in connection with the construction of dams in several parts of Africa, and have good reason to remember that they do not keep water either in or out much better than a sieve. It is porous rocks only that are capable of being laterized.

An American authority, Prof. W. J. Mead[41], writing on bauxite in Arkansas, describes it as having been derived from kaolin which is the result of alteration of underlying nepheline syenite. In the middle of the bauxite beds "horses" of unaltered kaolin are frequently found. These he states are always impermeable and says: "The alteration of clay to bauxite like other phases of rock decomposition is accomplished through the agency of circulating solutions. It is therefore reasonable to assume that the rate of alteration is dependent at least in part on the permeability of the clay." This is quite in accord with the writer's observations on laterite.

2. THE SOURCE AND SOLUTION OF LATERITIC MATERIAL.—*(a) Iron.* Ferric hydrate, in which form all iron is deposited in laterite, is derived mostly from the ferriferous minerals of rocks in the zone of permanent saturation. By the simultaneous action of alkaline carbonates and carbonic acid in aqueous solution the double silicates containing iron are broken up, any iron present in the ferric is reduced to the ferrous condition by means of organic compounds present in vadose water (these are usually called humic acid), the metal goes into solution as ferrous bi-carbonate and passes into the vadose water current. Some iron from

40 "Geology and Geography of Northern Nigeria," p. 200.

41 "Occurrence and Origin of the Bauxite Deposits of Arkansas," Econ. Geol. 1915, pp. 28-54.

the zone of non-saturation is also reduced in the same way by rain-water solutions percolating downward. This contains oxygen in solution when entering the soil but, since it is quite obvious that a solution containing free oxygen cannot reduce iron, the oxygen is neutralized either by humic acid or by ferrous iron. When it reaches water-level, if at any considerable depth, it certainly has no oxidizing power, otherwise laterite would always form in the zone of intermittent saturation. In this way iron from old laterites is slowly dissolved and passes down in solution to the vadose water.

The pores of permeable rock in the zone of non-saturation in laterite districts are filled mostly with carbon dioxide. This is well known to all who have done prospecting work underground in such places. Artificial ventilation is rarely necessary in temperate regions in prospecting shafts about 50 ft. deep worked one shift per day. The writer has never known such work to be possible in laterite country without the aid of a fan ; candles will not burn. The difference is very marked. This carbon dioxide is mostly driven off from alkaline carbonates by the silica of double silicates in their decomposition in the zone of permanent saturation.

It is important to realize that percolating rain water that passes through a heavy porous layer of rock does not contain free oxygen when it reaches vadose water and cannot therefore cause the precipitation of ferric hydrate. The exclusive mention of carbonic acid as the solvent of ferrous iron must not be taken to mean that other acids may not play some part. When sulphides exist we undoubtedly have sulphuric acid formed. The amount of this which acts as a solvent of iron in the tropics is insignificant when compared with carbonic acid. The nitric acid myth was mentioned previously.

The amount of iron carried in solution by vadose water depends upon the following:

(1) The amount of iron contained in the rock that is undergoing leaching principally in the zone of permanent saturation in the drainage area.

(2) The rate of fall of the mean vadose water-level. Vadose water-level falls at the same rate as the strata are eroded by rivers in the same area. The upper layers of rock in the zone of permanent saturation have their iron entirely leached as a rule. The depth of the zone is limited, for its water cannot circulate much below the level of the lowest drainage of the area. A very slow rate of denudation permits the mean vadose water-level to sink only very slowly and it therefore gets down to only a very limited quantity of new rock to leach.

(3) Crustal Movements. If crustal movements of a regional nature cause the strata to be depressed faster than erosion lowers the vadose water-level, it is obvious that practically no new rock will come within the zone of permanent saturation and very little iron can be dissolved.

(4) Solvent power of vadose water. Pure water does not dissolve iron ; carbonic acid and in general a reducing agent such as humic acid must be present. The supply of these is not unlimited and, if vadose water is to exercise its maximum solvent power, it must circulate slowly, which is possible only below gentle slopes in places where, and at seasons when the amount of rain absorbed at the surface is not excessive.

(*b*) *Aluminium*.—The aluminium hydroxide of laterite is derived either directly or indirectly from double silicates containing alumina. It may be obtained from all three surface zones.

Let us consider what happens when rain passes through a layer of kaolinized rock of a thickness of say 20 ft. above water-level. Rain has carbon dioxide and air in solution ; it takes up humic acid and alkaline carbonates from the soil. Oxygen is neutralized and a reducing carbonated solution of alkaline carbonates passes downward. The writer some years ago expressed the belief that such a solution exercises a selective solvent action on clays removing silica and leaving behind alumina as bauxite. Subsequent observation and the examination of various permeable surface layers exposed for long periods to the action of percolating rain-water solutions above water-level has proved that practically no free alumina exists in them. It cannot be doubted that alkaline carbonated water attacks hydrous silicate of alumina. When so attacked both the acid and basic radicles are removed in solution. Silica we know dissolves as alkaline silicate. We know that aluminium hydroxide in colloidal condition and also as the crystalline tri-hydrate are deposited from vadose water at its surface. This water is alkaline ; aluminium hydroxide is soluble in such water, and we are forced to conclude that it must be in the form of alkaline aluminate that is is transported. Rain water percolating downward therefore contains in solution alkaline aluminate, silicate, and carbonate, carbonic and organic acids, in addition to a little ferrous iron and other compounds of minor importance when it joins the vadose water.

It seems evident that lateritic material is formed in the zone of non-saturation; it does not collect there, however. Laterization is not the formation of such compounds; it is their deposition. In this connection it must be remarked (it will be demonstrated later) that a solution from which lateritic constituents may be deposited is also capable of redissolving them. Observation leads us to assert positively that lateritic constituents are not deposited in permeable strata in the zone of non-saturation; nor are they deposited in the zone of intermittent saturation when this is far below the surface or cut off by other means from contact with atmospheric oxygen.

Vadose water in laterizing areas has been found to contain alkaline carbonates and silicates, bi-carbonates of lime, magnesia, and ferrous iron, also manganese, titanium, humic acid, and traces of other compounds besides alumina. The latter is assumed to be present as alkaline aluminate, though this has not been proved.

The chemical reactions involved in the solution of alumina are best considered along with those involving its deposition. Before proceeding it is as well that it be distinctly understood that the leaching processes effected by percolating rain water and by vadose water are not laterization and have no necessary connection with it, and that only a very small quantity of the potential lateritic material contained in vadose water ever goes to form laterite even under the most favourable conditions. Laterization is the process by which the hydroxides of ferric iron, aluminium, and titanium are introduced into the mass of any rock near the surface. Laterization involves deposition only; to include the leaching of rocks in which little of the material dissolved ever forms laterite only involves confusion.

(*c*) ***Titanium***.—Titanium exists in cystalline rocks usually as ilmenite. The first change this undergoes is conversion into leucoxene by the leaching of ferrous iron, its replacement by calcium and even replacement of part of the titania by silica. By further alteration amorphous white compounds are formed which mix with amorphous hydrous silicate of alumina when their identity is not traceable by the microscope. A certain amount of titania is dissolved by vadose water but in what form is not known.

3. THE DEPOSITION OF LATERITIC CONSTITUENTS.—Lateritic constituents include ferric, aluminium, and titanium hydrates, with sometimes those of manganese, chromium, &c. Phosphoric acid, usually present in small quantity in vadose water, separates out along with the above hydrates, probably in combination.

(*a*) *Ferric Hydrate*.—Iron is always present in solution, mostly as bi-carbonate, in laterizing water. Upon coming into contact with oxygen these ferrous salts are oxidized to ferric and decompose depositing ferric hydrate. The condition of hydration of this is dealt with later under "The Minerals of Laterite." It is important to note that this reaction is exothermic, that is, it involves the evolution of a considerable amount of heat. In order that ferric hydrate may be a lateritic constituent it must be deposited within the mass of a porous rock near the surface or in rarer cases as an actual exterior coating on laterite. Under favourable conditions it fills the pores and cavities besides lining passages until a previously porous rock becomes almost impermeable. Hydrate of alumina is of course usually deposited at the same time. The way in which ferric hydrate is produced and deposited is in no way obscure: it has been observed frequently in actual operation. It is hardly possible to believe that the ferric hydrate of laterite is ever produced in any other way.

Certain authors have stated that the evaporation of water containing iron in solution brings about the precipitation of ferric hydrate. This is an error. In all cases iron, when present in a solution circulating in nature, is in the ferrous condition, never in the ferric. The presence of a reducing agent will preserve the iron in solution for a limited time in contact with oxygen, but ultimately it will be oxidized and precipitated as ferric hydrate. The concentration of the solution has no bearing on the matter. Even a very dilute solution of ferrous bi-carbonate will deposit its iron as ferric hydrate on contact with the air just as rapidly and completely as a much more concentrated solution.

The very small quantity of iron normally present in solution in river waters is assumed to be in the ferrous state probably ironized but, if combined, how we do not know. We have no evidence of the existence of any iron salt in solution in the ferric state except basic ferric sulphates such as copiapite which are intermediate compounds in the oxidation of pyrite under conditions of limited moisture. These are in solution for only short periods and separate as efflorescences. In solution they are incapable of being transported any distance in nature without complete decomposition, ferric hydrate remaining.

(*b*) *Aluminium Hydrate*.—Since it has been customary to represent the hydrolysis of double silicates and other slow changes in nature by chemical equations this method will be followed, though the writer admits the practice to be scientifically improper. The equation[42]:

$$2NaAlSi_3O_8 + 15H_2O + CO_2 = Al_2(OH)_6 + Na_2CO_3 + 6H_4SiO_4$$

is often given as representing the hydrolysis of albite resulting in the formation of aluminium hydrate, sodium carbonate, and silicic acid. This I cannot approve, since the change takes place in more than one stage and the different stages under dissimilar conditions. Double silicates do not yield aluminium hydrate in the laterizing zone. We have almost positive proof that it is from hydrous silicate of alumina exclusively that aluminium hydrate is formed in nature.

The hydrolysis of kaolin is said (on what authority I am unaware) to involve an endothermic reaction. Simple hydrolysis does not appear to be necessary however; the following series of reactions is much more probable:

(1) $Al_2O_3{,}2SiO_2{,}2H_2O + 4Na_2CO_3 + H_2O = Al_2(OH)_6 + 2Na_4SiO_4 + 4CO_2$
(2) $Na_4SiO_4 + 2CO_2 + 2H_2O = 2Na_2CO_3 + H_4SiO_4$
(3) $Al_2(OH)_6 + 3Na_2CO_3 = Al_2(ONa)_6 + 3CO_2 + 3H_2O$
(4) $Al_2(ONa)_6 + 3CO_2 + 3H_2O = Al_2(OH)_6 + 3Na_2CO_3$
(5) $Al_2(OH)_6 + 6NaOH = Al_2(ONa)_6 + 3H_2O$
(6) $Al_2(ONa)_6 + 3H_2O = Al_2(OH)_6 + 6NaOH$
(7) $Al_2(OH)_6 + 2H_4SiO_4 = Al_2O_3{,}2SiO_2{,}2H_2O + 5H_2O$

(2) is dependent upon temperature.
(4) certainly takes place, and its reverse (3) is extremely probable.
(5) and (6) the reverse of one another are well known.
(7) If the hydrolysis of kaolin is endothermic its synthesis must be exothermic.

Vadose water is a dilute solution containing alkaline carbonate, silicate, and aluminate in varying proportions with carbonic acid sometimes in excess and sometimes, locally perhaps, even free caustic alkali. There is the possibility of all the above mentioned reactions taking place depending upon conditions. It is obvious that it is a complex matter to define the conditions which permit free alumina to be deposited.

This much we know positively: 1, amorphous aluminium hydrate $Al_2(OH)_6$ is obtained by the action of carbon dioxide on alkaline aluminate; 2, crystalline aluminium hydrate $Al_2(OH)_6$ (gibbsite) is obtained when an aqueous solution of sodium aluminate decomposes spontaneously at about 20°C. or over. In the first reaction the amorphous form appears to require a large excess of carbonic acid and when it separates it attaches itself to solid matter in the vicinity. The presence of free aluminium hydrate facilitates both reactions. If amorphous hydrate is present in the second reaction the whole may separate in the amorphous form.

The conditions controlling these reversible reactions are obscure and work is being done in order to elucidate them. Aluminium hydrate is deposited only at the surface of vadose water; this is established by observation. Its deposition there must be the result of a change of conditions there.

The changes in conditions are: (1) Evolution of carbonic acid and heat consequent on oxidation of ferrous carbonate to ferric hydrate. (2) Increased temperature owing to solar heat. (3) Increased concentration of solutions, in capillaries especially, owing to surface evaporation.

Humic acid has been credited with some influence in the matter, but this cannot be accepted because it pervades the whole of the surface zones, whereas it is only in the zone of intermittent saturation that aluminium hydrate is deposited.

(*c*) *Titanium.* — Concerning the causes leading to the deposition of titanium in laterite nothing is known beyond the fact that it invariably accompanies ferric and aluminium hydrates in small quantity in the precipitate yielded by laterizing water when oxidized. The same alterations in conditions which lead to the separation of the more abundant constituents also cause its separation. The writer believed it to separate in combination with iron, but this view has been modified by subsequent observation. It is possible that much of the titanium of laterite is residual, having been left behind in the free hydrated condition in the leaching of the mother rock.

4. General Remarks.—Very little of either the iron or alumina dissolved in vadose water ever enters into the composition of laterite; a small portion separates out where conditions are favourable, whereas the bulk of them drains away in solution to the streams where it separates out and may be seen in abundance in some places. It is usually lost by admixture with large quantities of sedimentary material, but it seems possible that under exceptional conditions it might settle in a state of comparative purity and form laterite deposits. Dr. Fermor[43] claims to have identified such beds and classes them as "Lake Laterites." The writer, however, has never seen anything of this kind in process of formation and has not encountered any older beds that belong to this category unless the very fine-grained oolitic laterites such as occur near the

[42] *Geol. Mag.*, 1906, p. 547

[43] *Geol. Mag.*, Nov. 1911, p. 514.

Nigu River above Lokaja could have had this origin. The fact that they appear not to have any passages between the oolites lends support to this idea. In Africa such beds are rare and of very little importance.

Laterizing water, when issuing at the surface, seizes oxygen with avidity and, as a general rule, ferric and aluminium hydrates usually mixed with hydrous silicate of alumina separate out in a pale yellowish-brown almost jelly-like form.

In parts of Northern Nigeria, in zones of highly acidic rocks with abundant free quartz, laterizing water has been observed frequently to deposit only hydrous silicate of alumina at the surface. In parts of Southern Nassarawa the water of small streams assumes an almost milk-white turbidity from this cause. This phenomenon is most marked when the ground first reaches saturation and diminishes later in the season.

One notable characteristic of these solids separating on contact with the air is their colloidal condition; they pass quite freely and completely through filter paper of the closest texture.

The ratio between the amount of ferric and of aluminium hydrate in this precipitate varies very greatly, iron predominating strongly in most cases. It is only rarely that hydrous silicate of alumina was found to be entirely absent.

Since oxygen brings about this precipitation in laterizing water on the surface it is evident the same result will take place in the strata wherever oxygen comes in contact with it. The colloidal material may be observed in the pores of any permeable rock at water-level no matter whether it be loose sand, soil, or decomposed crystalline rock. Porosity and the presence of oxygen appear to be the necessary conditions determining this which is the commencement of laterization.

The composition of the amorphous mixture thus deposited in the pores of the altered rock cannot be determined with accuracy since it is impossible to be sure that the acid used as a solvent does not at the same time dissolve constituents of the rock.

The initial stages of laterization are most difficult to study since, in every case observed, colloids are found exclusively. When laterization commences as it usually does in permeable so-called kaolin, with or without quartz, the material becomes mottled in appearance owing to laterite constituents being deposited where porosity is greatest. The colour at first is yellowish brown but in many cases it rapidly turns red. Hydrous silicate of alumina next seems to go into solution at the immediate points where deposition takes place. Capillaries in this way coalesce and passages are formed varying greatly in size. In some of these dissolution continues, as is indicated by the rough interior, whereas in others deposition takes place inside, successive layers ultimately closing them entirely in some cases. Under other conditions the permeable kaolin is converted into a homogeneous still permeable mass composed of ferric and aluminium hydrates with hydrous silicate of alumina, all amorphous, in which the outlines of crystals of the original rock are faithfully retained.

Still another form of laterization occurs in which the three above-mentioned compounds are deposited in an impermeable form almost homogeneous and breaking with conchoidal fracture. A few passages traverse it. No evidence of origin is to be seen in its structure, but sections often show crystals of tourmaline, rutiles, zircon, &c. Sometimes it holds corroded quartz loose in cavities.

Records of structure deal almost exclusively with laterites which were formed thousands of years ago and have been subjected since to secondary changes which in most cases have profoundly altered both their appearance and composition. Hydrous silicate of alumina goes into solution in vadose water under certain conditions, but observation leads me to believe that such takes place to a very much greater extent in the zone of intermittent saturation than elsewhere. The most rational explanation of this (which is put forward merely as an hypothesis) is that it is connected directly with the decomposition of alkaline aluminate in which aluminium hydrate is deposited and free alkali liberated. Nascent free alkali is a powerful solvent and there is every reason to believe that it is liberated simultaneously with the formation of gibbsite.

Where quartz is admixed with kaolin, as in altered granite or gneiss, laterization frequently removes the quartz entirely. The writer has specimens of laterite derived from granite (Kumasi, Ashanti) in which hardly a trace of quartz remains; such small particles as are left are loose in cavities and have a corroded surface. The same has been observed in Northern Nigerian and Surinam laterites. Another, from the central province of Ceylon, shows quartz masses split up into sections by cracks; corrosion proceeded inward from the cracks but went on more rapidly than lateritic material was deposited so that its present appearance in section resembles a window each pane of which is a cavity partly occupied by corroded quartz.

Dr. Fermor[44] refers to quartz as "one of the insoluble constituents" of laterite. This view requires modification, for large quantities of quartz are in many cases completely removed. This fact does not seem to have been previously noted.

Prof. Lacroix[45] mentions a non-siliceous laterite from Wadai derived from granite and gives a rather curious explanation of the disappearance of the quartz. He supposes that after kaolinization the kaolin was washed down into a hollow, leaving the quartz behind and the kaolin laterized in its new position. The laterite contains rutile and zircon, minerals heavier than quartz; they should have remained behind. It appears much more probable that the quartz was dissolved during laterization. Prof. Harrison reports the occurrence of quartz veins formed in laterite after its deposition. They are secondary obviously and may arise from causes totally unconnected with the process of laterization.

The variety of forms which laterite presents is very great, varying from almost entirely amorphous to nearly completely crystalline, from almost entirely ferruginous to nearly pure aluminium hydrate, from a texture almost homogeneous to forms with over 60% pore space, and in colour from nearly black through brown, red, and yellow to nearly white. It is safe to say that any variety may be derived from pure white hydrous silicate of alumina.

We can now realize why it is that the composition of laterite does not depend, except in a minor degree, upon that of the rock from which it is derived.

In order to avoid being misunderstood it is as well to state that in saying a laterite is "derived" from a rock I am taking a liberty with the meaning of the word. It is used because other geologists have used it and because there is no word which has the exact signification required. Laterite is not derived (in the strict sense of the word) from a rock but is the result of the gradual removal of the greater part of the mineral matter of the original rock and the gradual deposition in its place of lateritic constituents from passing solutions.

Mr. E. A. Simpson[46] defines laterite as "a deposit accumulating in the actual space occupied by the solid rock which has yielded the materials which compose the laterite." This seems to mean that the whole of the material of a laterite occupying a given space has emanated from the portion of mother rock which previously occupied the same space. Then Mr. Simpson goes to the other extreme when he compares laterite to a saline efflorescence, the characteristic of which is that it forms on the surface or in an empty space. The actual space which it occupies cannot possibly be the same as that from which emanated the material composing it. The comparison seems pertinent only in so far as both laterite and saline efflorescences are capable of being re-dissolved by the medium from which they were deposited. A comparison with gypsum or ulexite when deposited as a layer or in concretions immediately below the surface in certain saline areas would probably have been happier. The cause of deposition of a saline efflorescence is essentially different from that of laterite, the former being due to evaporation and the latter primarily to oxidation.

(To be continued).

[44] *Geol. Mag.*, 1911, p. 461.
[45] Op. Cit., p. 316.
[46] *Geol. Mag.*, 1912, p. 401.

Technical Societies.—The autumn meeting of the Institute of Metals will be held at 4 p.m. on September 19, at the rooms of the Chemical Society, Burlington House. The following are the papers to be read:

Experiments on the Fatigue of Brasses, by B. Parker Haigh; Hardness and Hardening, by Professor Thomas Turner; The Effects of Heat at Various Temperatures on the Rate of Softening of Cold-rolled Aluminium Sheet, by Professor H. C. H. Carpenter and L. Taverner; A Comparison Screen for Brass, by O. W. Ellis; A High Temperature Thermostat, by J. L. Haughton and D. Hanson; Principles and Methods of a New System of Gas-Firing, by A. C. Ionides; Fuel Economy Possibilities in Brass-Melting Furnaces, by L. C. Harvey; The Effect of Great Hydrostatic Pressure on the Physical Properties of Metals, by Professor Zay Jeffries; The Use of Chromic Acid and Hydrogen Peroxide as an Etching Agent, by S. W. Miller. Special attention is drawn to Mr. Ionides' paper.

The Iron and Steel Institute will hold its autumn meeting at the Institution of Civil Engineers on September 20 and 21. The following papers will be presented:

Present Practice in Briquetting Iron Ores, G. Barrett and T. B. Rogerson; Microstructure of Commercially Pure Iron between Ar_3 and Ar_2, W. J. Brooke and F. F. Hunting; Influence of Heat Treatment on the Electrical and Thermal Resistivity and Thermo-electric Potential of some Steels, E. D. Campbell and W. C. Dowd; New Impact Testing Experiments, G. Tharpy and A Cornu-Thenard; Heat Treatment of Grey Cast Iron; Effect of Mass on Heat Treatment, E. F. Law; Investigations upon a Cast of Acid Open-hearth Steel, T. D. Morgans and F. Rogers; The Acid Open-hearth Process, F. Rogers; Eggertz Test for Combined Carbon in Steel, J. H. Whiteley; Failure of Boiler Plates in Service and Investigation of Stresses Occurring in Riveted Joints, E. B. Wolff.

LETTERS TO THE EDITOR

Our American Friends.

The Editor :

Sir—I am prompted to write to you for two reasons : first, to promote goodwill between England and America ; second, to shake hands, as it were, with those whom I used to address when I occupied the position that you now fill so efficiently. My reading of English papers and of letters from friends in England tells me that not many on your side understand the position of America toward the War. Europeans generally, Englishmen particularly, are apt to look upon the United States as a country peopled by men of British descent ; for that reason they resent the slowness with which, so it seems to them, the United States rose to its opportunity, or duty, in the great crisis created by German aggression. By reference to the census statistics you will find that 37% of the population of this country was born in Europe or born of European parents ; if to this you add the 10,000,000 negroes, you will find that barely 50% of the population of the United States consists of white people born of native-born parents. It is true the old leaven of British stock still leavens the lump ; the English language, the English common law, the ideas of fair play and of clean fighting are the common heritage of our peoples, but anyone wishing to understand the American nation must recognize that a large part of it is of other than British origin and that even some of those that are of our origin are inclined to assert their alienation from the mother country and to emphasize their Americanization at the expense of old ties. Of course, if you, sir, were to visit New York or San Francisco you would meet persons predominantly of English origin and of English sympathy, because a man instinctively finds his own kind, but, being an observant man, you would note that the people in the street-car were unlike your own friends and you would be wise in concluding that the American people is not represented by the habitues of good clubs or fine hotels, any more than the English people, in time of peace, are represented by those lounging at the Cecil or the Savoy. Of the workmen on the pay-rolls of the big copper companies in Arizona you will find 50% that are not only non-British, but non-American, aliens in appearance and speech, and yet many of them are voters. The first 13 names drafted for the War in San Francisco were Franz Koszuoki, Frederick Engelhardt, Umberto Dianda, Rafael Gamboa, Fritz Weibel, Kurt L. Guessdorf, James L. Joseph, Charles H. Dryer, Ylisses M. Markris, Manao Ishimoto, John Pellegrini, Leon Stimmel, and Thomas G. Caldaroni. Of course, you may say this is a "grab" sample, and therefore unrepresentative ; but it is suggestive. You will note representatives from Poland, Italy, Spain, Germany, Greece, and Japan, and one possibly British name. This is a nation yet in the making ; the process of assimilation is yet so incomplete that an occasional attack of political dyspepsia is not surprising. The United States has been called a melting-pot ; a year ago it wás only a mixing-pot. The temperature was kept so low, by presidential request, that no fusion was possible. Neutrality may have prevented domestic discord, but it tended to disintegrate the people according to their European sympathies. The country of our adoption made no call upon us, while the country of our origin (I speak as a European by birth) appealed to us by the heroic part it was playing. Presumably even Germans and Austrians felt the same way. The temperature in Europe rose to above boiling-point, here it was kept at zero by official decree. And wisely. You demur to that, I expect ? Allow me to say confidently that if the President had taken decisive action a year earlier, leading to American participation in the great struggle, he would have had a distracted country behind him. Mr. Wilson was re-elected last November because "he kept us out of war." At that time probably 75% of the American people wished to remain at peace ; some (as in other countries) were too ignorant to understand the meaning of the great catastrophe ; some did not see why the United States should be drawn into it ; others may have had mercenary reasons for abstention, hoping to profit by the prosperity due to the necessities of the warring nations across the Atlantic ; a large number loved peace at any price, and another large number—possibly 25%—were pro-German in sympathy. Opposed to this heterogeneous majority there was a minority of those normally in sympathy with English and French thought, and to these should be added others that had been aroused to strong antagonism against German brutality. You still think that the minority ought to have been the majority ? You do not allow for "the fortuities of place and cold interposition of the sea." I ask you to make allowance for the effect of American school-books, in which children were told of British tyranny, overlooking the fact that the revolutionists of 1776 were British just as much as their opponents, and that the war of 1812 was a wretched little affair—and I am glad it was—happening at a time when England was engaged in a struggle that made the American fight a mere side-show. When a Blumenfelt or a Rosenstein exclaims on the Fourth of July that "This is the day when we licked the British," he makes me tired. In the future American historians will have something to write about besides the Revolution and the Civil War ! And it will help to broaden the mind of the American school-boy. To proceed. If a vote had been taken even on the day when Von Bernstorff was given his passport, it is probable that a majority would have voted against war ; and even to-day there is a large body of opinion deeply regretful, some of it profoundly resentful, of giving American aid to the Allies. Here *we* are 7,000 miles from the battlefield ; *you* can hear the guns ; that makes a difference. I venture to add, however, that as soon as we begin to receive detailed accounts of the American navy in action and of the American flag in the battle-smoke there will be a sudden growth of enthusiastic interest in the fighting and of keen sympathy for the cause. Even in England and her overseas dominions the people did not awaken to the stern reality of war until their wounded began to come home.

One more idea I wish to present : This democracy has been led into the War by its thinking element, by the intellectuals, by its head, not by its feet ; the professors, lawyers, editors, and publicists, the professional men and the more cultured among business-men, by these the United States was led to war ; and at the head of them was a university professor, the President. Whether it was the opportunism of a statesman or the listening leadership of a politician that gave the final touch, I do not know ; but I do believe that Mr. Wilson will obtain credit in history for profound wisdom in displaying patience under the severest provocations from the enemy, and in delaying final action until the right moment. Personally, I wish that one or two of those diplomatic notes could be removed from the record—but it is human to err. The point I wish to make is that this republic was persuaded to enter the fight against Pan-Germanic aggression by a relatively small proportion of thinking men, not by mob emotion or the hysteria of the crowd. At all events—thank God—we are now fighting organized hell side by side. We shall see it through. We are going to make the world safe for orderly living. We are going to be friends; and that is better than being "cousins." The Lord gives us our relatives and we find our friends. A friend is the one whom you know well and still like. Whatever the origins of the American people, it is a unit now on the side of right. To some of us the delay in action has been extremely painful, but we are putting that behind us, and look forward to the time when England, France, and America—and the youngest of the democracies, Russia, also—shall stand in defensive alliance against any criminal attempt to bring upon civilization another pentecost of calamity.

T. A. Rickard.

San Francisco, July 20.

The Metric System.

The Editor:

Sir—As a strong believer in the metric system, I rejoice that the discussion in the Institution of Mining and Metallurgy, last November, and your editorial, in the June Magazine, are both favourable to its adoption. I have been familiar with the discussion of the subject for many years and, personally, I am strongly in favour of its compulsory adoption by the United States; I will cheerfully pay my share of the expense incurred by making the change from our present complicated and annoying weights and measures, which Lord Kelvin characterized as "a brain-wearying, intellect-destroying system." I heartily agree with Sir Benjamin Baker, builder of the Forth Bridge, who said: "I am equally familiar with both systems, in consequence of having carried out works abroad, and when I return to this country (England) from such work and experience with the metric system, I think there is nothing more foolish in this world than our weights and measures." Mr. Ingalls and other opponents of the metric system are right in assuming that its compulsory adoption will be expensive and that it will take time to make the change; but everything worth having must be paid for. Moreover, it is well to remember that the retention of our present muddle is expensive. Dr. J. V. Collins, of Wisconsin, has prepared a pamphlet—A Metrical Tragedy—in which he asserts that the annual loss by our failure to use the metric system in the United States is \$315,000,000. No one knows if this is a correct estimate, but we are certainly losing large sums annually by refusing to adopt the metric system. It is to be remembered that the cost of making the change will be paid once for all, while the loss by not changing will go on indefinitely and will soon greatly exceed any possible cost of changing.

It seems to me that the opponents of the metric system look too much to the present; suppose that it does take a long time to make the change and works some inconvenience, let us start now. In fact, we have started in the United States, and much work is being done with metric units. Dr. Stratton, chief of the Bureau of Standards, is a powerful supporter of the movement. In his "Metric System in the Export Trade" (64th Congress, 1st Session, Senate Doc. 241) I note: "a large and well-known locomotive works handled an order for 100 locomotives, all dimensions of which were in metric measure. Not a dimension was translated, and from drawing room to assembling, the job was handled in the metric system. The executive in charge of the work stated to a Government representative that the adoption of the metric system for this and other orders did not cost a penny extra. We already work to all kinds of scales, even in our English units, and the metric unit simply added an extra scale. Our mistakes were fewer with the metric order and loss for rejects less than on our regular line. The use of the metric system was indeed found to be easier in many respects, and we fill all orders for metric sizes of products in the metric system. That is the common-sense method and is no trouble at all." The United States Department of Agriculture also employs some metric units in the charts on nutrition that are at this moment being studied by millions of housewives. There is every reason to hope that the metric system will ultimately prevail, but the incredibly unreasoning conservatism of the English-speaking people will cause a long delay; possibly the metric system will come into use about the same time as the scientific spelling of English, say in a thousand years?

It is not worth while bringing forward any detailed arguments as to the superiority of the metric system. The arguments on both sides have been set forth in voluminous detail in Volume xxiv, 1903, of the Transactions of the American Society of Mechanical Engineers, pages 396 to 712. In these 317 pages every side of the subject has been exposed in minute detail, and all the inquirer needs is there so plainly set forth that he should have no difficulty in coming to a decision. Mine has been already given above, and I hope that every reader of this will use his best efforts to extend the use of the metric system, even if he does not believe, as I do, in its compulsory adoption.

W. H. Shockley.

Palo Alto, California, July 15.

NEWS LETTERS.

VANCOUVER, B.C.

July 27.

The Coal Strike and After.—The strike at the coal mines and coke ovens in the Crow's Nest district, on the eastern and western side of the Rocky Mountains, in Alberta and British Columbia respectively, has at last come to an end, and the resumption of work is having a beneficial effect on the metal-mining industry, especially seeing that coke is again obtainable for the smelting works at Trail, Grand Forks, and Greenwood. It is not to be expected that a return to the flourishing conditions that prevailed at the time labour troubles arrested progress several months ago will be immediate, for a large number of men who were thrown out of employment at some of the mines left the districts affected, but the fact that activity again prevails at the larger mines will induce many of these men to return.

Production of ore on a large scale has not yet been resumed at Rossland. The total quantity shipped from this district to the Consolidated Co.'s smelter at Trail was 994 tons during the month of June and 308 tons in the three weeks ended July 21. Of the June output, 827 tons was from the Consolidated Co.'s Centre Star group of mines and 167 tons from its Le Roi mine. The July production shown above was from the Centre Star group only. A few cars of ore have been shipped from the Josie group of the Le Roi No. 2, Ltd., to the smelting works at Ladysmith, Vancouver Island, but this is probably only a temporary arrangement pending receipt at Trail of sufficient coke to warrant the blowing-in of the copper furnaces there. It is expected that on August 1 one copper furnace will be in blast, or perhaps more, as coke supplies are coming in with some regularity. Owing to a barge on Kootenay Lake having temporarily gone out of use, the transport of ore from the Sullivan lead mine, East Kootenay, to the Trail smelter has been interrupted.

The ore receipts at Trail for the week ended July 21 included 29 tons from the Lanark mine, Illecillewaet, along the main line of the Canadian Pacific, east of Revelstoke. Another small lot, of 41 tons, was received from the same mine early in May. It is of interest to recall that the first production of ore in quantity from a lode mine in British Columbia was made by the Selkirk Mining & Smelting Co., which in 1887 and 1888 shipped to a smelter in San Francisco 422 tons of sorted silver-lead ore from the Lanark mine. One lot of 64 tons of ore shipped by the present operators of the mine, shortly after they bonded it, was officially reported to average 34% lead and 33 oz. silver per ton, while 32 tons averaged 29% lead and 26 oz. silver. Last year's shipments to Trail totalled 415 tons. An aerial tramway, 6,900 ft. in length, in two sections of 3,600 ft. and 3,300 ft. respectively, was constructed late in the autumn of 1915 from the railway up to the mine, the difference of elevation between terminals being about 2,600 ft. The ore in the lower levels contains so much zinc that it has been necessary to provide a concentration plant. This will have a capacity of 75 tons per day. There is about 15,000 tons of ore in sight, which is expected to average about 7 to 8% lead and 12 to 15% zinc. As in many other instances of re-opening of mines in Kootenay long inactive, those who are now working the Lanark are Spokane men.

It is announced, as I send this letter, that coke shipments from the Fernie ovens to the Granby Consolidated Co.'s smelting works at Grand Forks did not come up to expectations, so resumption of operations has been somewhat delayed. It had been hoped to have blown-in four furnaces on July 20, but this had to be postponed for some days. At the company's mines at Phœnix, the full force of miners is at work, and two shipments of ore reached the smelting works toward the end of July. Small shipments of coke from the ovens of the International Co., at Coleman, Alberta, to supply the smelter at Greenwood, have been commenced, and it is expected the furnaces will be running at full capacity in August.

TORONTO.

August 11.

PORCUPINE.—Though the relations between mine-owners and their employees have greatly improved and all danger of a strike is averted, production is being much curtailed owing to labour shortage. This difficulty is at present intensified on account of the urgent demand for men to help in saving the harvest, many men having left the mines to gather the grain crops. There is some competition among the leading mines for workers. The Hollinger Consolidated is paying a flat rate of $4 per day to all underground labour, which is the highest figure ever paid in Northern Ontario, and has increased its working force considerably. It is thus able to carry on development on an unprecedented scale, employing about 40 machines working on every level from the surface to the 1,250 ft. level. Progress is being made at the rate of about a mile a month. The object of the directors is to install milling facilities for handling 3,800 tons of ore per day. To maintain the supply of ore at this rate a large number of working faces are necessary. The Dome Mines has passed its dividend, as has been for some time anticipated. Development operations have been much curtailed owing to labour scarcity. The mill is treating 1,500 tons of ore daily, but the content is quite low, as the ore is being taken from the more convenient workings. The construction of a new high-grade mill is under consideration in order to provide for the economical treatment of the ores from the lower levels. An important ore-body has been found by diamond-drilling at the depth of 1,150 ft. The Schumacher has begun the installation of machinery at its new mill, which will bring the total capacity of the plant up to 400 tons per day, and is adding considerably to its mining equipment so as to maintain the increased ore supply. The Porcupine Crown is sinking its shaft from the 900 ft. level to 1,100 ft. It is anticipated that it will follow the example of other leading mines and conserve its surplus by a temporary suspension of dividends. The McIntyre is driving on the main vein at the 1,000 ft. level. This vein, on being followed, divided into two branches, one of which, 12 ft. in width, carries ore of very high quality.

COBALT.—Mine-owners are taking advantage of the present high price of silver to speed-up production. Shipments during July showed a considerable increase as compared with the earlier months of the year. The total bullion shipments for the current year up to August 4 amounted to 6,100,344 oz., valued at $4,614,843. Of this the Nipissing furnished 3,127,652 oz. and the Mining Corporation of Canada 2,531,028. The labour agitation has completely subsided. The rise in the price of silver to over 80c. per oz. is accompanied by an additional bonus to the miners of 25c. per day, and as long as this is continued no further trouble is likely to occur.

NEW GOLD DISCOVERY.—A new discovery of gold has been made in Rickard Township, about 40 miles north-east from Porcupine and four miles south of the Abitibi River. The outcrop of basalt and porphyry in which the veins occur is about one square mile in extent and has all been staked. Development work however is held up for the time being, as the Abitibi Pulp & Paper Co. is constructing a dam in the neighbourhood, which when completed may flood a portion of the gold-bearing area. The claims will not be recorded until some arrangement can be effected under which the company will not be held responsible for possible damages.

WEST AUSTRALIA.

June 20.

WESTONIA.—The Edna May Consolidated has purchased a 10 head stamp-mill, and the manager estimates that he will be able to keep it going on ore assaying 70s. per ton, which was the average of trial crushings amounting to 1,200 tons of ore. This company, conjointly with the Edna May Central and Main Lode companies, is sinking a vertical bore-hole in such a situation as should prove the country to the advantage of the three companies in laying out their future development work. The Edna May company has decided to reduce its dividends from 3s. to 2s. in order to provide for a larger reserve fund than has been possible under the higher rate. The payment of dividends amounting to almost the whole of the cash resources has been characteristic of many Australian companies, so that when additional expenditure is required urgently, calls have to be made. Attention was drawn to this at the recent Mining Conference, and it is to be hoped that more attention will be paid to it in the future, as the bad practice lends itself to market manipulations. English companies operating in Western Australia have been much more reasonable in this regard.

KALGOORLIE.—The Great Boulder Perseverance has had its first month's run on the reduced tonnage of 11,786 tons, for a return of £11,659, which shows a loss of £2,880. This loss should be reduced when the system is in full swing, but owing to the shrinkage system in vogue in this mine it is impossible to increase the grade, when desired, to compensate for the decreased tonnage.

The result of the proceedings in the Federal Arbitration Court for an increase in the rate of wages with decreased hours is awaited with interest. Gold mining has been hit hard by the War. The cost of cyanide, zinc, explosives, spare parts, and general stores has increased considerably, which, together with a decrease in efficiency in the miners now available, and without a rise in the price of the product as is the case with the base metals, make it almost impossible for several of the low-grade mines to keep going. Economies have been effected where possible, but any increase in wages without a compensating increase in tonnage broken will mean that some of these mines must shut down. In spite of this obvious fact, the agitators controlling the Miners' Unions will not recognize the suicidal nature of their policy.

GREENBUSHES.—Owing to the high price of tin, mining in this district is active. There are five dredges at work and two more are being erected. At the Ethel May and the adjoining claim a return has recently been made of 7 tons 12 cwt. of tin oxide from 386 tons of wash.

NULLAGINE.—Work will shortly be resumed on the Nullagine tin-sluicing area. The new manager, who has had considerable experience in sluicing in the eastern States, estimates that 3,500 cubic yards could be treated weekly, at a fair margin of profit. One of the difficulties lies in the hardness of the wash, but a scarcity and inferiority of labour in this district is a much bigger factor in costs. The distance inland to be travelled under the heat of summer is such that good men will not go there

TUCKIABANNA.—This new mining centre in the Murchison district is engaging the attention of a number of prospectors. Hitherto only quartz reefs carrying rich patches of gold ore have been worked. Now the lodes are being properly prospected. The Butterfly company, which has a working option in the Blue Streak lease, is sinking the shaft and will test the lode at the 200 ft. level. A trial crushing of 35 tons taken from the No. 1 level gave an average of 120s. per ton. On the lease next to the Blue Streak the owners are sinking on a promising lode which runs parallel to and about 180 ft. west of the Blue Streak lode. On the Tosiana 135 tons of ore, taken from a width of 9 ft., returned an average of over 80s. by amalgamation, with nearly as much in the tailing. The most recent discovery, the cap of a lode, was cut about a mile and a half to the south-east of the Blue Streak. Prospecting work is being carried on for a distance of four miles along this belt of country, and its future will be watched with keen interest.

COLLIE.—At a recent send-off to Mr. F. J. Price, who has been manager of the Westralian Coal Mining company and other mines during the past seven years, he stated that Collie is in the best position in the Commonwealth from a geographical point of view, as far as bunkering coal was concerned, which branch of the industry has not been developed to anything like the extent it should have been. More up-to-date methods should be adopted to increase bunkering. There are several varieties of coal on the Collie coalfield, each of which is adapted for a specific use. There is an abundance of coal yet to be won from West Australia; with proper handling the possibilities of the Collie coalfield are practically illimitable. The early completion of the Transcontinental Railway will possibly mean that Fremantle will be the terminus for the mail steamers from England, and if so the bunkering trade should be built up to cope with the demand.

PERSONAL.

SYDNEY H. BALL has gone to Western Siberia.

CAPTAIN H. B. BATEMAN, R.A., joined the East African Expeditionary Force in June.

P. G. H. BOSWELL has been appointed to the recently founded Herdman Chair of Geology in the Liverpool University.

C. L. DAKE, assistant professor of geology in the Missouri School of Mines, has joined the staff of Valerius, McNutt, & Hughes, during a year's leave of absence from the School.

H. EWER JONES, who is connected with the British Red Cross in France, was home on leave last month.

F. C. FREY, manager of the Redjang Lebong mines in Sumatra, is in the United States on holiday.

J. L. GALLARD, mining editor of *The Financial Times*, has received the rank of lieutenant, after serving in the motor transport of the Army Service Corps at the front in France for over two years.

F. LYNWOOD GARRISON has returned to Philadelphia from the West Indies

T. J. GREENWAY left on his return to Australia on August 27.

ROBERT T. HILL has completed his report on the geology of Southern California made for the United States Geological Survey, and has returned to private practice, with an office at Los Angeles.

A. F. KUEHN has gone to the United States on business connected with the Burma Corporation and will proceed thence to the mine.

DR. MALCOLM MACLAREN has returned from Peru.

W. W. MEIN has been visiting the new copper district north of The Pas, Manitoba.

CHARLES O'BRIEN has been appointed metallurgist to the Butters Salvador Mines.

HENRY MACE PAYNE has been appointed assistant to the president of the Bertha and affiliated coal companies, and has moved his office from New York to 1203, Chamber of Commerce Building, Pittsburgh.

GUY C. RIDDELL has completed his work in connection with the enlargement and reorganization of the Broken Hill Associated Smelters lead works at Port Pirie, and has returned to America.

L. W. SIMPSON has left for Nigeria.

SIR H. ROSS SKINNER has been transferred from the Ministry of Munitions to the Admiralty for special work in connection with the Board of Invention and Research.

R. O. H. SPENCE has returned to British Guiana.

J. E. SPURR recently visited the new copper-gold district north of The Pas, Manitoba.

H. G. WALTON, for many years associated with Bewick, Moreing & Co. in Australia, has been appointed manager for the Riverina South Gold Mining Co., at Mulline, West Australia.

J. P. B. WEBSTER has returned to London after 20 months' sojourn in Russia.

E. W. WESTERVELT has been appointed manager of the Hobson silver-lead mine, Ymir, B.C.

JOHN YATES has discontinued his courses of instruction in mining at Johannesburg, and has settled at Durban. He was a great success as a teacher.

We regret to announce the death of A. C. SIM, for many years the representative in this country of Werf Conrad, the Dutch firm of dredge-builders. He was elected Associate Member of the Institution of Civil Engineers in 1886, and as an engineer had made a special study of dredging for both civil and mining engineering purposes.

METAL MARKETS

COPPER.—The official price of standard was reduced during the month to £120–£120. 10s. cash and £119. 10s. to £120 for three months. The interest of the market centres round the proceedings of the United States government in fixing a price for their purchases. It is fully understood that the present level of electro is too high, but the level popularly placed on the cost of production is much lower than facts warrant. Consumers appear to be well stocked on the other side, having purchased well ahead so as to ensure supplies. Left without their continued support and in the absence of the government's decision the market has become lifeless and prices have sagged away. Electro is quoted 2 cents lower at 24–25 cents f.o.b. New York for September–December delivery, the prolonged suspension of demand having had its effect on sellers. Supplies are reported as plentiful, in spite of the strike, and it is felt that a revival of demand can be met without serious difficulty. The labour position is obscure. Reports to hand indicate, however, that the conditions are improving.

Average prices of cash standard copper: August 1917, £122. 10s. 5d.; July 1917, £128. 13s. 2d.; August 1916, £110. 8s. 3d.

TIN.—Price movements for August have been confined within somewhat narrow limits. Official control is being strictly exercised, with the object of preventing inflation of price, and permits are now being granted more sparingly. The allied governments have been heavy buyers, but their purchases have had little apparent effect on prices. English buying has been dull, tinplate manufacturers not having been able to adjust themselves to the new regulations in force. American business is quiet, but indications are given from time to time of increasing demand; they have been buying in the East at over London parity. China sales have become difficult, owing to the rise in silver. The heavy backwardation has now run off and is now only 10s. The visible supplies at the end of August show an increase of 2,039 tons, rather more than the market expected.

Average prices of cash standard tin; August 1917, £243. 18s. 8d.; July 1917, £242. 6s. 6d.; August 1916, £169. 19s. 9d.

LEAD.—The official quotation continues to be £30. 10s.–£29. 10s. The American market is also steady. Supplies are still scarce in this country and likely to remain so, as no increase in output can be looked for. The disturbances in Spain have naturally interfered with supplies from that quarter.

Average prices of soft foreign lead: August 1917, £30; July 1917, £30; August 1916, £29. 2s. 7d.

SPELTER.—This metal has been in steady demand and the official quotation has remained unaltered during the month at £54–£50. American consumers are quiet and there is a weakening tendency in prices. Production there continues on a large scale. Dealings in this country are under strict official control.

Average prices of good ordinary brands: August 1917, £52; July 1917, £52; August 1916, £47. 19s. 7d.

The Australian Zinc Producers' Association quotes zinc dust at £95 to £98 per ton, according to quality, at United Kingdom ports.

SILVER.—The London market is denuded of supplies, and the demand continues. The price gradually mounts, and from 42d. per standard ounce a month ago rose to 50d. on September 11. The Indian position is rendered difficult by the fact that silver is now worth more as bullion than as rupees, and the government has had to prohibit both imports and exports.

No quotations for aluminium, antimony, or manganese.

CHROMIUM.—The Government has taken control of all supplies of chrome ores. Ferro-chrome £70 to £160 per ton according to carbon content.

NICKEL.—£225 per ton. COBALT.—11s. per lb.

BISMUTH.—11s. per lb. CADMIUM.—7s. 6d. per lb.

TUNGSTEN.—Wolfram and scheelite, basis 70% WO_3, 55s. per unit. Ferro-tungsten 5s. 6d. per lb. Tungsten powder 6s, 3d. per lb.

MOLYBDENUM.—Molybdenite 90% MoS_2, 105s. per unit. Ferro-molybdenum 16s. per lb.

PLATINUM.—New 290s. per oz.; scrap 160s. per oz,

QUICKSILVER.—£20 to £25 per flask of 75 lb.

PRICES OF CHEMICALS. Sept. 8.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d.
Alum	per ton	15	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	32	0	0
,, Chloride of, grey	per cwt.	1	18	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	70	0	0
,, Phosphate of	,,	95	0	0
,, Sulphate of	,,	15	10	0
Arsenic, White	,,	110	0	0
Bleaching Powder, 35% Cl.	,,	19	0	0
Borax	,,	37	0	0
Copper, Sulphate of	,,	63	0	0
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		11	4
Iron, Sulphate of	per ton	5	10	0
Lead, Acetate of, white	,,	100	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	46	0	0
Magnesite, Calcined	,,	14	0	0
Magnesium Sulphate	,,	11	0	0
Phosphoric Acid	per lb.			10
Potassium Carbonate	per ton	115	0	0
,, Chlorate	per lb.		2	6
,, Chloride 80%	per ton	60	0	0
,, Hydrate, (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	75	0	0
,, Permanganate	per lb		15	0
,, Prussiate, Yellow	,,		3	6
,, Sulphate, 90%	per ton	65	0	0
Sodium Metal	per lb		1	9
,, Acetate	per ton	85	0	0
,, Bicarbonate	,,	7	15	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	4	0	0
,, Hydrate, 76%	,,	26	0	0
,, Hyposulphite	,,	20	0	0
,, Nitrate, 95%	,,	25	10	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	7	0	0
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	33	0	0
Sulphur, Roll	,,	21	0	0
,, Flowers	,,	23	0	0
Sulphuric Acid, non-arsenical 144°T.	,,	4	5	0
,, non-arsenical 95%	,,	7	0	0
Superphosphate of Lime, 18%	,,	5	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
July, 1916	733,485	27,602	761,487	3,232,891
August	752,940	28,210	781,150	3,318,116
September	744,881	26,686	771,567	3,277,408
October	764,489	27,850	792,339	3,365,642
November	756,370	26,696	783,066	3,326,253
December	748,491	25,971	774,462	3,289,705
Year 1916	8,971,359	324,179	9,295,538	39,484,934
January 1917	756,997	25,637	782,634	3,324,418
February	696,955	24,366	721,321	3,063,976
March	760,598	26,496	787,094	3,343,363
April	717,598	25,180	742,778	3,155,121
May	753,531	26,034	779,385	3,310,618
June	732,799	26,925	759,724	3,227,101
July	731,848	25,991	757,839	3,219,094
August	731,405	25,253	756,658	3,214,079

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1916	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500
October 31	199,330	10,907	6,358	216,595
November 30	196,132	11,118	5,928	213,178
December 31	191,547	11,487	5,194	208,228
January 31, 1917	188,624	11,611	5,591	205,826
February 28	191,095	11,568	6,268	208,931
March 31	190,028	11,494	6,620	208,142
April 30	185,975	11,435	6,314	203,724
May 31	180,168	11,432	5,805	197,405
June 30	175,727	11,258	5,369	192,354
July 31	171,653	11,381	5,223	188,257
August 31	170,817	11,401	5,028	187,246

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
July 1916	2,370,244	26 1	17 10	8 0	949,606
August	2,423,669	26 3	17 10	8 1	976,125
September	2,367,793	26 6	18 0	8 3	972,704
October	2,453,437	26 4	17 10	8 2	1,001,843
November	2,389,056	26 9	18 2	8 2	980,387
December	2,349,191	26 10	18 2	8 4	977,481
January 1917	2,337,066	26 10	18 8	7 11	941,520
February	2,153,691	27 3	19 2	7 10	841,259
March	2,430,590	26 7	19 0	7 4	879,351
April	2,235,833	27 2	19 2	7 8	857,710
May	2,405,855	26 4	18 7	7 5	887,527

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1916	1917	1916	1917
	£	£	£	£
January	318,586	296,113	140,579	131,665
February	313,769	289,734	137,739	104,892
March	335,368	300,183	150,987	158,727
April	339,386	297,977	135,976	123,825
May	323,783	299,271	132,976	121,104
June	333,070	302,195	127,107	114,489
July	322,365	288,731	128,574	142,017
August	338,001	...	125,143	...
September	322,035	...	127,138	...
October	325,608	...	132,577	...
November	317,135	...	130,101	...
December	306,205	...	146,409	...
Total	3,895,311	2,073,204	1,615,306	896,719

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
July, 1916	912	91,725	92,637	393,495
August	*	89,522	*	*
September	*	85,978	*	*
October	*	82,732	*	*
November	*	87,322	*	*
December	*	88,205	*	*
January 1917	*	83,962	*	*
February	*	81,810	*	*
March	*	76,171	*	*
April	*	82,144	*	*
May	*	78,165	*	*
June	*	82,600	*	*
July	*	81,166	*	*
August	*	80,181	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1916	1917	1916	1917	1916	1917
	£	£	£	£	£	£
January	89,900	67,627	66,700	50,150	39,000	29,000
February	76,500	65,450	79,050	63,200	30,000	26,000
March	103,600	74,794	76,920	61,200	36,000	41,000
April	60,000	75,139	83,300	62,470	63,000	21,000
May	119,500	65,623	116,230	65,450	19,000	28,400
June	86,000	...	72,200	73,100	18,000	24,600
July	100,600	...	85,400	71,820	23,000	44,000
August	66,800	...	86,000	...	24,000	...
September	115,100	...	65,450	...	32,000	...
October	81,400	...	74,800	...	32,000	...
November	94,000	...	60,300	...	31,000	...
December	96,600	...	73,550	...	111,000	...
Total	1,090,000	302,124	940,500	447,340	459,000	214,000

Production of Gold in India.

	1914	1915	1916	1917
	£	£	£	£
January	193,140	201,255	192,150	190,047
February	185,508	195,970	183,264	180,904
March	191,853	194,350	186,475	189,618
April	189,197	196,747	192,208	185,835
May	193,031	199,786	193,604	184,874
June	192,224	197,447	192,469	182,426
July	195,137	197,056	191,404	179,660
August	196,560	197,984	192,784	181,005
September	195,843	195,952	192,330	...
October	198,191	195,531	191,502	...
November	197,699	192,714	192,298	...
December	211,911	204,590	205,164	...
Total	2,340,259	2,366,457	2,299,568	1,474,369

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper Standard	Copper Electrolytic	Copper Best Select'd	Soft For'n Lead	Zinc	Tin Standard	Silver
Aug.	£	£	£	£ s.	£ s.	£ s. d.	d.
13	125	137	135	30 10	54 0	242 10 0	$42\frac{1}{16}$
14	125	137	135	30 10	54 0	242 10 0	$42\frac{1}{2}$
15	125	137	135	30 10	54 0	244 0 0	44
16	120	137	135	30 10	54 0	244 15 0	44
17	120	137	135	30 10	54 0	244 5 0	44
20	120	137	135	30 10	54 0	243 0 0	$44\frac{1}{2}$
21	120	137	135	30 10	54 0	242 5 0	$44\frac{3}{4}$
22	120	137	135	30 10	54 0	242 0 0	$44\frac{3}{4}$
23	120	137	135	30 10	54 0	241 15 0	$44\frac{3}{4}$
24	120	137	135	30 10	54 0	241 0 0	$44\frac{7}{8}$
27	120	137	135	30 10	54 0	240 0 0	45
28	120	137	135	30 10	54 0	241 10 0	45
29	120	137	135	30 10	54 0	242 10 0	$45\frac{1}{2}$
30	120	137	135	30 10	54 0	244 0 0	46
31	120	137	135	30 10	54 0	244 10 0	46
Sept.							
3	120	137	135	30 10	54 0	243 5 0	47
4	120	137	135	30 10	54 0	241 15 0	$47\frac{1}{2}$
5	120	137	135	30 10	54 0	241 0 0	$48\frac{1}{2}$
6	120	137	135	30 10	54 0	240 15 0	$48\frac{1}{2}$
7	120	137	135	30 10	54 0	241 5 0	49
10	120	137	135	30 10	54 0	241 0 0	$49\frac{1}{2}$
11	120	137	135	30 10	54 0	242 0 0	50

Imports of Ores and Metals into United Kingdom.

These figures do not include Government imports.

* Statistics not published. Long tons.

	Year 1916	June 1917	July 1917	Year 1917
	Tons	Tons	Tons	Tons
Iron Ore	6,905,936	*	*	*
Copper Ore	34,492	*	*	*
,, Matte and Precipitate	43,839	1,599	920	12,923
,, Metal	111,412	5,447	6,853	50,760
Copper and Iron Pyrite	951,206	*	*	*
Tin Concentrate	33,912	*	*	*
,, Metal	33,646	1,872	2,729	17,448
Manganese Ore	439,509	*	*	*
Lead, Pig and Sheet	157,985	12,204	7,331	70,250
Zinc (spelter)	53,324	2,519	4,339	30,776
	lb.	lb.	lb.	lb.
Quicksilver	2,556,214	—	449,120	526,136

Exports of Copper from United States

These figures are circulated by news agencies and it is not always possible to verify their correctness.

1916	Long tons	1916	Long tons	1917	Long tons
January	21,863	July	35,048	January	25,540
February	20,548	August	34,700	February	24,937
March	24,006	September	28,572	March	51,246
April	19,980	October	32,712	April	79,001
May	14,700	November	21,433	May	45,241
June	38,277	December	21,438	June	39,816
		Total 1916	313,277	Total 1917	265,783

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1916 Tons	July 1917 Tons	Year 1917 to date
Bisichi (Nigeria)	473	15	172
Briseis (Tasmania)	467	31	211
Dolcoath (Cornwall)	1,076	69	515
East Pool (Cornwall)*	1,012	81	610
Gopeng (F.M.S.)	1,113	91	601
Malayan Tin (F.M.S.)	1,104	63	440
Mongu (Nigeria)	576	58	331
Naraguta (Nigeria)	523	45	278
N. N. Bauchi (Nigeria)	578	45	305
Pahang (F.M.S.)	2,591	220	1,520
Rayfield (Nigeria)	658	50	350
Renong (Siam)	894	55	531
Siamese Tin (Siam)	906	47	481
South Crofty (Cornwall)*	700	58	401
Tekka-Taiping (F.M.S.)	651	35	242
Tongkah Harbour (Siam)	1,135	97	746
Tronoh (F.M.S.)	1,662	89	610

* Including Wolfram.

Stocks of Tin.

Reported by A. Strauss & Co. Long tons.

	June 30, 1917	July 31 1917	Aug. 31, 1917
	Tons	Tons	Tons
Straits and Australian, Spot	2,595	2,488	2,277
Ditto, Landing and in Transit	50	900	1,527
Other Standard, Spot and Landing	293	744	964
Straits, Afloat	5,000	4,093	4,973
Australian, Afloat	85	30	—
Banca, on Warrants	—	—	—
Ditto, Afloat	2,567	1,817	2,147
Billiton, Spot	—	—	—
Ditto, Afloat	233	290	273
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,530	1,410	1,045
Afloat for United States	4,095	5,145	5,380
Stock in America	2,332	1,722	2,092
Total Stock	18,780	18,639	20,678

Shipments and Imports of Tin

Reported by A. Strauss & Co. Long tons.

	Year 1916	Aug. 1917	Total 1917
	Tons	Tons	Tons
Shipments from:			
Straits to U.K.	27,157	3,195	19,499
Straits to America	25,943	2,025	16,077
Straits to Continent	8,487	550	6,790
Australia to U.K.	2,537	—	349
U.K., Holland, and Continent to America	14,863	1,100	9,435
Imports of Bolivian Tin into Europe	15,116	2,355	11,915
Deliveries in U.K.	16,862	932	8,589
" ,, Holland	943	1,027	1,448

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1912	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531	665
February	240	427	469	358	528	645
March	247	510	502	418	547	653
April	141	430	482	444	486	554
May	144	360	480	357	536	497
June	121	321	460	373	510	461
July	140	357	432	455	506	464
August	201	406	228	438	498	...
September	196	422	289	442	535	...
October	256	480	272	511	584	...
November	340	445	283	467	679	...
December	310	478	326	533	654	...
Total	2,540	5,103	4,708	5,213	6,594	3,939

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons
January	4,121	4,983	4,395	4,316	3,558
February	3,823	3,555	3,780	3,372	2,755
March	3,562	3,839	3,653	3,696	3,286
April	4,066	4,087	3,619	3,177	3,251
May	4,319	4,135	3,823	3,729	3,413
June	3,993	4,303	4,048	3,435	3,489
July	4,245	4,582	3,544	3,517	...
August	4,620	3,591	4,046	3,732	...
September	4,379	3,623	3,932	3,636	...
October	4,409	3,908	3,797	3,681	...
November	3,976	4,085	4,059	3,635	...
December	4,614	4,351	4,071	3,945	...
	50,127	49,042	46,767	43,871	19,752

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1915	4,918	£448,362	£90 14 6
Year 1916	4,668	£478,194	—
January 2, 1917	176	£17,677	£100 8 10
January 15	160¾	£16,681	£103 15 5
January 29	152	£16,095	£105 17 10
February 12	182½	£20,649	£113 6 1
February 26	176¾	£19,700	£111 9 3
March 12	179	£20,468	£114 7 0
March 26	161¾	£19,875	£122 17 8
April 10	179	£22,024	£123 2 0
April 23	169	£21,429	£126 16 0
May 7	167	£22,248	£133 4 6
May 21	168½	£23,772	£141 5 9
June 4	168	£22,474	£133 15 6
June 18	158½	£21,915	£138 5 4
July 2	159½	£21,661	£135 16 1
July 16	144½	£18,896	£130 19 11
July 30	168	£23,225	£138 5 0
August 13	160½	£21,757	£135 15 4
August 27	156½	£21,429	£136 18 6

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Sept. 5, 1916 £ s. d.	Sept. 5, 1917 £ s. d.
RAND:		
Bantjes	16 6	2 6
Brakpan	4 8 9	5 8 9
Central Mining (£8)	6 7 6	6 5 0
Cinderella	6 3	4 0
City & Suburban (£4)	1 16 3	1 8 9
City Deep	4 5 0	3 18 9
Consolidated Gold Fields	1 13 9	1 12 6
Consolidated Langlaagte	1 8 9	1 2 9
Consolidated Main Reef	17 6	16 0
Consolidated Mines Selection (10s).	1 0 0	1 6 9
Crown Mines (10s.)	2 11 3	2 10 0
Daggafontein	15 9	16 9
D. Roodepoort Deep	13 9	11 3
East Rand Proprietary	15 0	7 6
Ferreira Deep	1 7 6	16 3
Geduld	2 3 6	1 19 6
Geldenhuis Deep	1 3 0	1 1 3
Gov't Gold Mining Areas	2 7 0	3 8 0
Heriot	2 7 6	1 15 0
Jupiter	8 0	4 9
Kleinfontein	1 11 9	1 3 3
Knight Central	13 0	3 3
Knight's Deep	1 8 9	16 3
Langlaagte Estate	17 3	16 0
Main Reef West	7 9	3 6
Meyer & Charlton	5 3 9	5 3 9
Modderfontein (£4)	18 17 6	21 2 6
Modderfontein B	6 16 3	8 2 6
Modder Deep	7 2 6	7 0 0
Nourse	17 0	19 6
Rand Mines (5s.)	3 8 9	3 5 0
Rand Selection Corporation	3 11 3	4 7 6
Randfontein Central	11 0	11 9
Robinson (£5)	16 3	18 9
Robinson Deep	1 15 0	1 7 6
Rose Deep	1 2 6	17 6
Simmer & Jack	6 6	7 0
Simmer Deep	2 6	3 3
Springs	2 17 6	3 8 9
Van Ryn	1 18 9	1 15 0
Van Ryn Deep	3 8 9	3 5 0
Village Deep	1 12 0	1 1 9
Village Main Reef	13 0	13 9
Witwatersrand (Knight's)	2 15 0	2 0 0
Witwatersrand Deep	1 2 6	11 0
Wolhuter	11 0	8 3
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	15 0	18 0
Sheba (5s.)	1 9	1 3
Transvaal Gold Mining Estates	1 4 6	1 0 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	12 13 9	13 7 6
Jagersfontein	3 18 9	4 7 6
Premier Deferred (2s. 6d.)	5 10 0	7 10 0
RHODESIA:		
Cam & Motor	11 6	11 6
Chartered British South Africa	13 0	14 0
Eldorado	9 0	7 3
Falcon	14 6	17 3
Gaika	10 0	8 3
Giant	7 6	7 6
Globe & Phœnix (5s.)	1 8 0	1 13 9
Lonely Reef	1 0 6	1 7 6
Rezende	7 6	3 2 6
Shamva	1 12 0	1 7 6
Wanderer (3s.)	1 3	2 0
Willoughby's (10s.)	5 0	6 3
WEST AFRICA:		
Abbontiakoon (10s.)	6 6	5 0
Abosso	9 3	7 6
Ashanti (4s.)	17 9	1 2 0
Prestea Block A	8 3	5 9
Taquah	1 0 0	17 9
WEST AUSTRALIA:		
Associated Gold Mines	3 6	3 0
Associated Northern Blocks	3 3	2 9
Bullfinch	4 3	2 0
Golden Horse-Shoe (£5)	1 16 3	1 17 6
Great Boulder Proprietary (2s.)	12 9	12 9
Great Boulder Perseverance	9	9
Great Fingall (10s).	1 3	1 3
Ivanhoe (£5)	2 2 6	2 1 9
Kalgurli	12 0	8 9
Sons of Gwalia	15 0	13 6

GOLD, SILVER, *cont.*	Sept. 5, 1916 £ s. d.	Sept. 5, 1917 £ s. d.
OTHERS IN AUSTRALASIA:		
Mount Boppy, New South Wales	10 0	5 0
Talisman, New Zealand	11 3	12 6
Waihi, New Zealand	2 2 0	1 18 0
Waihi Grand Junction, New Z'lnd	18 9	16 0
AMERICA:		
Alaska Treadwell (£5), Alaska	5 7 6	1 2 6
Buena Tierra, Mexico	13 0	13 0
Camp Bird, Colorado	8 0	8 0
Casey Cobalt, Ontario	5 0	9 6
El Oro, Mexico	9 6	11 0
Esperanza, Mexico	11 9	10 6
Frontino & Bolivia, Colombia	11 6	11 6
Le Roi No. 2 (£5), British Columbia	10 0	8 0
Mexico Mines of El Oro, Mexico	3 12 6	6 2 6
Oroville Dredging, California	16 9	17 0
Plymouth Consolidated, California	1 2 6	1 4 0
St. John del Rey, Brazil	15 3	18 6
Santa Gertrudis, Mexico	12 0	12 0
Tomboy, Colorado	1 2 6	18 6
RUSSIA:		
Lena Goldfields	1 18 9	1 12 6
Orsk Priority	1 6 3	17 6
INDIA:		
Champion Reef (2s. 6d.)	6 6	6 0
Mysore (10s.)	3 15 0	3 4 6
Nundydroog (10s.)	1 7 0	1 7 9
Ooregum (10s.)	1 0 9	19 9

COPPER:	Sept. 5, 1916 £ s. d.	Sept. 5, 1917 £ s. d.
Arizona Copper (5s.), Arizona	2 1 3	2 6 3
Cape Copper (£2), Cape Province	4 0 0	3 17 6
Chillagoe (10s.), Queensland	3	3
Cordoba (5s.), Spain	3 0	3 0
Great Cobar (£5), N.S.W.	3 6	2 0
Hampden Cloncurry, Queensland	1 16 3	1 9 6
Kyshtim, Russia	2 14 6	1 18 9
Messina (5s.), Transvaal	11 0	8 0
Mount Elliott (£5), Queensland	3 18 9	5 5 0
Mount Lyell, Tasmania	1 6 3	1 4 9
Mount Morgan, Queensland	1 17 6	1 12 6
Rio Tinto (£5), Spain	61 15 0	63 5 0
Sissert, Russia	1 2 6	1 0 0
Spassky, Russia	2 2 6	1 12 6
Tanalyk, Russia	2 14 6	1 15 0
Tanganyika, Congo and Rhodesia	2 10 0	3 7 6
Tharsis (£2), Spain	5 0 0	5 0 0

LEAD-ZINC:	Sept. 5, 1916 £ s. d.	Sept. 5, 1917 £ s. d.
BROKEN HILL:		
Amalgamated Zinc	1 11 6	1 12 6
British Broken Hill	1 6 3	1 15 0
Broken Hill Proprietary (8s.)	2 19 9	2 7 0
Broken Hill Block 10 (£10)	1 3 9	1 5 0
Broken Hill North	2 7 3	2 15 0
Broken Hill South	8 6 3	8 18 9
Sulphide Corporation (15s.)	1 6 6	1 8 0
Zinc Corporation (10s.)	15 9	1 2 0
ASIA:		
Burma Corporation	3 10 6	4 1 3
Irtysh Corporation	2 10 0	1 13 9
Russian Mining	1 1 3	15 0
Russo-Asiatic	6 5 0	3 15 0

TIN:	Sept. 5, 1916 £ s. d.	Sept. 5, 1917 £ s. d.
Aramayo Francke, Bolivia	1 7 6	1 12 6
Bisichi, Nigeria	8 0	15 0
Briseis, Tasmania	4 6	5 0
Dolcoath, Cornwall	10 0	9 6
*East Pool, Cornwall	1 15 0	13 6
Ex-Lands Nigeria (2s.), Nigeria	1 6	1 9
Geevor (10s.) Cornwall	7 3	16 3
Gopeng, Malay	1 10 0	1 12 6
Ipoh Dredging, Malay	18 0	15 0
Malayan Tin Dredging, Malay	1 17 6	1 18 9
Mongu (10s.), Nigeria	8 6	14 6
Naraguta, Nigeria	13 9	15 6
N. N. Bauchi Pref. (10s.), Nigeria	5 9	12 3
Pahang Consolidated (5s.), Malay	11 9	12 0
Rayfield, Nigeria	6 3	11 9
Renong Dredging, Siam	1 10 0	2 15 0
Ropp (4s.), Nigeria	16 6	19 3
Siamese Tin, Siam	2 16 3	2 18 9
South Crofty (5s.), Cornwall	15 3	19 6
Tekka, Malay	3 5 0	3 12 6
Tekka-Taiping, Malay	2 6 3	3 10 0
Tronoh, Malay	1 8 9	1 10 6

* £1 shares split into 4 of 5s. each in August 1917.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

TITANIUM AND ITS USES.

The *Bulletin* of the Imperial Institute, No. 1, 1917, just published, contains an article on the occurrence of titanium ores and the commercial uses of titanium alloys and titanium compounds. We quote from this article at some length.

MINERALS.—Titanium in the form of titanic oxide (TiO_2) is one of the most widely distributed elements of the earth's crust. Rutile, the commonest natural form of titanic oxide, is rarely found in large deposits, but enormous quantities of ilmenite, or titaniferous iron ore, carrying varying amounts of titanic oxide occur in many localities. These two minerals are used as sources of titanium. Rutile is known to occur compact or massive in igneous, sedimentary, and metamorphic rocks; it varies in colour from yellow to reddish-brown and black, and gives a pale-brown streak. The hardness is about 6·5 and specific gravity 4·2 to 4·3. The mineral usually contains 98 to 99% of titanic oxide and 1 to 2% of ferric oxide. Ilmenite, or titaniferous iron ore, is an iron-black mineral occurring massive or in the form of thin plates or grains. Its hardness is 5 to 6, specific gravity 4·5 to 5·0, and lustre sub-metallic. The fracture is conchoidal, and streak brownish-red to black. Its composition is represented by the formula FeO, TiO_2, which corresponds to 47·3% of ferrous oxide and 52·7% of titanic oxide. Other minerals containing a large percentage of titanium are titanite or sphene, which is calcium titanium silicate, and brookite and octahedrite, crystalline forms of titanic oxide.

DISTRIBUTION OF ORES.—Only those deposits which are or have been worked to any extent, and those within the Empire which are probably capable of being worked, will be described in this article. In Europe, the principal rutile-producing deposits are those of Kragerö, to the north-east of Kristiansund in Norway. The output of rutile from Kragerö for 1912 was reported to be 100 metric tons of material containing 95% of titanic oxide, of total value £1,900.

In Canada, ilmenite occurs in great abundance in various parts of Quebec, and is often associated with rutile. Localities of special importance are those of St. Urbain, near Baie St. Paul; Rawdon; Château Richer; near mouth of Rapid River (Bay of Seven Islands); Saguenay River; and shores of Lake Kenogami. One of the most important deposits is that first mentioned, where there is a bed of ore 90 ft. thick exposed for a length of 300 ft., followed by other outcrops a mile away. The ore is ilmenite associated with rutile. The deposit was formerly worked as an iron ore. It was also worked in 1910 by the General Electric Co., who used it in the manufacture of electrodes for arc lights. The material quarried contained from 45 to 50% of titanic oxide. An output of 3,596 tons of this ore is reported for 1910. Part of it is stated to have been shipped to the Titanium Alloy Co., of Niagara Falls, N.Y., and used in the manufacture of ferro-titanium. The deposit near the mouth of the Rapid River (Bay of Seven Islands) is reported to be a large one. The ore here contains about 34% of titanic oxide, but can be enriched by magnetic separation to yield a product containing over 50% of titanic oxide. The black sands of the St. Lawrence are rich in ilmenite.

The titaniferous iron ore at St. Charles, Quebec, has been described by Professor Alfred Stansfield, in a Memoir by J. A. Dresser published by the Mines Department of Canada. This deposit is one of titaniferous magnetite occurring as large segregation masses in anorthosite or gabbro. Estimates of the amount of ore available are uncertain, but it is considered likely that there will be 1,000,000 tons, or possibly as much as five times this amount. A sample of the ore was found to contain 50·53% of iron, and 10·55% of titanium, with 0·02% of sulphur, and 0·03% of phosphorus.

According to recent reports the only company producing rutile in the United States is the American Rutile Co. at Roseland, Nelson Co., Va. The rock containing the rutile is stated to be a syenite, in which the mineral occurs as disseminated grains as well as in the form of segregated masses. The rock quarried at Roseland contains on the average 4 to 5% of rutile. Ilmenite is obtained as a by-product. In 1914 the output of the American Rutile Co. was 94 tons of rutile containing 95% of titanium dioxide, and 89 tons of ilmenite containing about 55% of titanic oxide. The output for 1915 is reported to be 250 tons of rutile worth between $25,000 and $30,000, together with a considerable quantity of ilmenite as a by-product.

As regards India, ilmenite is the chief constituent of the crude monazite sands of Ceylon and Travancore. These sands might be expected to yield ilmenite as a by-product at a cheap rate.

Samples of rutile have been received at the Imperial Institute from the Gold Coast and from near Baicossa, about 20 miles north of Obudu station in Nigeria. The Nigerian material was mixed with ilmenite and was stated to occur abundantly as a loose gravel at the surface

Samples of rutile and ilmenite from Nyasaland have been examined at the Imperial Institute. A sample consisting of a mixture of these two minerals was obtained from veins in gneiss on the Nankande river. About 50% of the sample was rutile, and the rest chiefly ilmenite. The sample contained 75·04% of titanic oxide, 11·86% of ferric oxide, and 11·56% of ferrous oxide.

Ilmenite and rutile occur at numerous localities in Queensland, and it is stated that many tons of rutile could be gathered at the mines on the Herberton tinfields.

Rutile occurs, and has been worked, in the hundred of Talunga, about 6 miles north of Blumberg, South Australia. The workings, which are about 150 yards in length, consist of small shafts and trenches in a kaolinized dyke formation from 10 to 12 ft. wide, striking slightly east of south. Rutile crystals of varying size occur distributed throughout this matrix, and can be extracted by panning. On the surface for some distance on either side of this formation fine rutile can be obtained. The mineral also occurs in a small seam of gravel about 12 in. below the surface. The average yield from these workings amounts to about 1½% of the material treated. The deposits appear to have been prospected only to a very limited extent. Nearly 2,000 lb. of rutile was produced at Para Wira in 1907 from 2,000 tons of gravel. Rutile occurs at a number of other localities in this State, but has not been worked. A notable deposit of ilmenite occurs near Olary, in South Australia. It is associated with uranium minerals and has been worked in recent years as a source of radium compounds. An analysis of a specimen of this ilmenite at the Imperial Institute gave 51·85% of titanic oxide, 17·87% of ferric oxide, and 17·37% of ferrous oxide.

An alluvial deposit containing rutile is described as occurring on the Westwood estate, Forth district, Tasmania. Analysis of a sample obtained from this deposit has shown the presence of 91% of titanic oxide, whilst a sample sent to the Imperial Institute in 1915 to see if any market could be found for it proved to be of good and saleable quality.

Greenbushes, Western Australia, is quoted by the Geological Survey of that State as a locality for rutile.

Titaniferous iron sands occur at a number of places on the west coast of both North and South Islands of New Zealand, the best-known deposits being the Taranaki sands, which extend from Waitotara to the Awakino River in the former island. No estimate of the quantity of iron available in this region appears to have been made, except at Patea, where, it has been calculated, the equivalent of nearly 5½ million tons of iron oxide is available for smelting purposes, not counting the immense amount of low-grade material (containing more than 25% by volume of quartz, sand, or shell-fragments) which would be available if a sufficiently cheap method of concentration were devised. Other workable deposits in this district occur at New Plymouth, Waitara, and Mokau. According to the most recent reports the Patea and New Plymouth sands can be concentrated magnetically to contain 50-60% of metallic iron. They are rich in titanium, however, containing from 6·2 to 10·6% of titanic oxide; by magnetic concentration the proportion of titanium is increased slightly relatively to the iron. The amount of phosphorus in the untreated sands varies from 0·16 to 0·28%, and pig iron made from such sands would contain about 0·5% of phosphorus.

UTILIZATION OF ORES.—At the present time the chief use of titanium is in the purification of steel and iron. It is used in two forms: (1) as titanium carbide, and (2) as an alloy with iron. The former is prepared by reducing the ore, mixed with carbon, in the electric furnace, the product consisting of microscopic particles of titanium carbide held in a matrix similar to grey cast iron. Such a material, containing from 15 to 20% of titanium and known as ferro carbon-titanium, is the principal form in which titanium is used in steel in the United States at the present time. The method employed for obtaining the titanium-iron alloy consists in the use of molten aluminium as a reducing agent. The titaniferous iron ore is charged into a bath of molten aluminium kept fused in an electric furnace. The iron is reduced first, and in this the titanium, as it is reduced by the aluminium, dissolves, yielding ferro-titanium. If rutile is used, scrap iron is charged into the bath before the mineral. By this means alloys containing from 10 to 75% of titanium and only 0·12 to 0·75% of carbon can be produced in quantity.

A method of concentration to produce an alloy rich in titanium from low percentage titaniferous iron ore has been tried. The ore, consisting of 15% titanic oxide, 80% iron oxide, and 5% gangue, was smelted in an electric furnace with just sufficient carbon to reduce the iron and leave all the titanic oxide unreduced in the slag. By this means a good quality pig iron was produced and a slag in which all the titanic oxide was concentrated. The slag was utilized as a source of titanium for the production of ferro-titanium.

Ferro-titanium alloys of German origin are usually produced by the Goldschmidt process, which consists in mixing the oxide to be reduced with finely powdered metallic aluminium and starting interaction by means of a fuse. A rapid reaction occurs, and the titanic oxide is reduced to the metallic state, the aluminium combining with the liberated oxygen to form alumina.

Titanium is chiefly used for the purification of rail steel, although its use in other steels is growing steadily. The presence of certain elements in minute quantities in steel has a far-reaching effect on its quality; and of these elements nitrogen is one of the most important. According to Braune, the effect of nitrogen is at first to increase slightly the toughness and reduce the ductility. Hard steel containing from 0·030 to 0·035% of nitrogen becomes quite brittle, while soft steel loses its ductility when the amount of nitrogen reaches 0·05 to 0·06%. The presence of nitrogen also favours segregation of the phosphorus and sulphur, causing cold shortness. Dr. Tholander found that a steel which normally contained 0·012 to 0·022% of nitrogen on being overblown in a converter for three minutes, contained 0·032% of nitrogen. The removal of the greater proportion of the nitrogen normally found in steel is a matter of much importance; and it is stated that this can be attained by the use of titanium, which combines with nitrogen at a temperature of 800° C. to form titanium nitride. Titanium has a melting point of 1,850° C. and a specific gravity much less than that of iron; these physical properties preclude the use of titanium itself, and lead to the use of the carbide or an alloy of titanium and iron instead of the pure metal, which would float on the fused steel and be difficult to dissolve. Exhaustive experiments with titanium alloys have shown that the best results are obtained with an alloy containing from 10 to 15% of titanium. The steel works in the United States which employ ferro-titanium specify an alloy of this composition. The alloy is added just as the steel runs into the ladle, that is, after recarburization and the addition of the necessary ferro-manganese and ferro-silicon. An instantaneous reaction occurs, and after a short time the slag formed by the reaction (chiefly titanic oxide) rises to the surface. According to the experience of von Maltitz, the addition of 0·5% of ferro-titanium, containing 10 to 15% of titanium, equal to a maximum consumption of 1·7 lb. of titanium per ton of steel produced, is sufficient in most cases to purify steel for rails to the desired extent.

The beneficial effect of titanium alloy in preventing segregation of the sulphur, phosphorus, and carbon, and in concentrating the blowholes in the pipe cavity, has been demonstrated by the experiments of many well-known metallurgists in America. Improvement was also noticed in the working of the steel in the rolling mill. The rails produced were found to give much better service than ordinary Bessemer steel rails. Tests on steel rails laid at a crossing at a New York railway station showed that in six months the steel treated with ferro-titanium had lost by flange-wear less than one-third of the amount lost by the Bessemer rails which preceded them.

The quantity of titanium-treated steel rail produced in the United States during recent years has decreased considerably. The decrease is said to be due to the fact that most of the steel previously treated was Bessemer steel, whereas this is but little used now in the United States for heavy rails, and the open-hearth steel does not appear to benefit by treatment with ferro-titanium to the same extent as Bessemer steel.

The beneficial effects of using titanium alloy for purifying basic open-hearth steel were demonstrated by experiments carried out in the Osnabrück steel works. In every case the bars treated with alloy showed increased strength, the fracture showing a fibrous structure similar to that of forged iron. In bending tests the titanium-treated steel also gave results superior to those obtained with untreated steel. Improvement was even seen with the addition of such a small quantity of titanium as 0·04%.

In addition to the above-mentioned uses for ferro-titanium as a purifier for steel, it is stated that certain manufacturers of crucible steel in the United States are adding the alloy in sufficient quantity to retain 0·05 to 0·20% of titanium in the finished steel. The addition of this is said to increase the toughness and durability of the tool steel produced. Titanium-iron alloy, containing 5·8% of carbon, is also used to some extent for improving the quality of iron by removing occluded gases and preventing segregation of subsidiary constituents. The quantity added varies from 1 to 3 lb. of 10% ferro-titanium to each 1,000 lb. of metal. It has been demonstrated by the experiments of Moldenke that the improvement is most noticeable in machinery pig (grey) iron. These experiments showed that the average crushing strength of machinery pig iron was increased 52% by the use of 0·5% of the ferro-titanium alloy. Results indicating similar improvements have been recorded when the alloy is added to metal for chilled car wheels, rolls, and to malleable iron. In the case of chilled car-wheel iron, the titanium treatment increases the crushing strength considerably.

An alloy of copper and titanium, containing from 5 to 12% of the latter element, is stated to be valuable for addition to copper castings. A. J. Rossi recommends the addition of 1 to 2% of this alloy to the molten copper, as it enables the copper to be cast in sand without difficulty, eliminates oxide and absorbed gases, and gives the metal a close-grained dense structure free from blow-holes. Cupro-titanium is now finding a use in the United States for degasifying copper and its alloys, and an alloy containing copper 93%, titanium 5%, and magnesium 2% is stated to be still more effective for the purpose. The physical properties of aluminium bronze are said to be considerably improved by treating the alloy with titanium. The treated alloy is stated to equal phosphor or manganese bronze in strength, to be considerably lighter and little affected by sea-water.

Another form in which titanium is used for purifying metals is that known as titanium thermit. This consists of a finely powdered mixture of metallic aluminium, oxides of titanium and iron, enclosed in a tin, which is attached to an iron rod and introduced into the ladle immediately after the metal is run from the furnace. Its function is similar to that previously described for ferro-titanium, the oxides of titanium and iron being reduced to the metallic state by interaction with the metallic aluminium. Alloys of titanium and silicon are also made for use in the steel industry where it may be desirable to add both these elements. These alloys can be produced containing 5 to 70% of titanium and 20 to 75% of silicon by reduction in the electric furnace of suitable quantities of silver sand and pure titanic oxide.

Pure titanium, which has a melting point of about 1,850°C. and a specific gravity of 5·17, does not appear to have been put to any industrial use as such.

SMELTING OF TITANIFEROUS ORES.—Closely connected with the general question of the utilization of titanium ores is that of the use of iron ores containing small quantities of titanium. The objections made by iron smelters to the use of such material are not that it produces an inferior quality of iron, but that it gives pasty slag, and that the aggregations of titanium nitride and nitrocyanide in the furnaces render working difficult. It is also stated that more fuel is necessary than in the case of non-titaniferous iron ore. In the past, highly titaniferous iron ores have been successfully smelted in various localities. An iron company which had works at Norton, near Stockton-on-Tees, many years ago smelted successfully an ore containing 39·2% of titanic oxide to yield forge iron. The fuel and fluxes employed were about 17 cwt. of coke, 12 cwt. of limestone, and 3 to 4 cwt. of basalt or similarly fusible silicate per ton of ore. Owing to the uncertainty of the supplies and the small quantity of iron in the ore the work was abandoned.

The question of the smelting of titaniferous iron ore is thoroughly discussed, and the results of many important blast-furnace experiments quoted in an article by A. J. Rossi in the Transactions of the American Institute of Mining Engineers for 1892, where he shows that it is possible to obtain a good pig iron and a fluid slag from ores containing 20% of titanic oxide.

Iron ore fairly high in titanic oxide was formerly mined and smelted in Sweden, but the production is stated to have ceased in 1904. In the larger of the Swedish furnaces which smelted this ore, the consumption of fuel is stated to have averaged 275 bushels of charcoal to the ton of ore, a consumption considerably in excess of that required for non-titaniferous ore. Ores carrying a high percentage of titanium were successfully smelted in blast furnaces during a period of 20 years in the Adirondack Mountains, New York State; the ores from this locality rarely contain less than 8% and often as much as 15% of titanic oxide. J. T. Singewald has investigated the possibility of utilizing the titaniferous iron ores of the United States and concludes that, for the present at all events, the outlook on the whole is not promising, although there are two large high-grade deposits, at Sandford Hill, in the Adirondacks, N.Y., and Iron Mountains, Wyoming, which are readily accessible and their utilization within a few years seems certain. Experiments on the magnetic separation of the ilmenite from the magnetite in the ores gave varying results, but in some cases it was possible to prepare concentrates that required the admixture of only a small proportion of non-titaniferous ores to make a satisfactory ore mixture. In 1914 an attempt was made to utilize the Sandford Hill ore, which consists approximately of two-thirds ilmenite and one-third magnetite. By treatment with Wetherill separators a concentrate was obtained containing about 55% of iron and $11\frac{1}{2}$% of titanium. This was smelted in a blast furnace with magnetite in proportions varying from $\frac{1}{16}$ to $\frac{5}{16}$ of the total charge, and contrary to the usual assertion, it is stated that the slag was unusually fluid and the fuel consumption normal. It was found difficult to make pig iron containing 2% of silicon or over, as there is a tendency for titanium to replace silicon; malleable pig iron made from a charge containing $\frac{5}{16}$ of titaniferous concentrate contained 0·5% of titanium.

The iron ore smelted by the natives of the Salem district, India, by the Catalan process, is stated to carry a certain amount of titanic oxide. It was reported in January 1916 that an ore carrying 7% of titanium dioxide was being smelted for iron at Belleville, Canada. The possibility of utilizing the deposits of titaniferous iron ore at St. Charles, Quebec, by means of electric smelting has been discussed recently by Prof. A. Stansfield.

Several attempts have been made to smelt the Taranaki iron sands of New Zealand, but great difficulty has been met with owing to the physical nature of the ore and the amount of titanium present. In 1892, 45 tons of pig iron were made at Onehunga, near Auckland, by a process devised by E. M. Smith, in which the sand is briquetted with clay before smelting. Samples of steel made at Onehunga from the Taranaki sand are exhibited in the New Zealand Court of the Public Exhibition Galleries of the Imperial Institute. The pig iron made by this process contained too much phosphorus and sulphur to be used in the acid Bessemer or Siemens processes, but otherwise it was of good quality. Although the prospects of the industry were favourably reported on at the time by various experts, including G. J. Snelus, efforts to raise capital to work the deposits were unsuccessful. More recently a process has been devised in which 60% of iron sand is briquetted with 40% of small coal from the Liverpool state colliery, and the briquettes coked before smelting. An experimental blast-furnace was erected near New Plymouth, and 3 tons of pig iron was produced in 1914. This, however, like that made by Smith's process, was above the Bessemer standard in phosphorus, but the titanium contained in the iron sand was largely eliminated in the furnace. No further information as to the quality and analysis of the pig iron is available.

From a review of the literature on this question it would appear that under suitable conditions the smelting of iron ores containing a moderate percentage of titanium should be a commercial possibility, especially as there are enormous quantities of such ore, which is usually very low in phosphorus, obtainable at a low price. Titaniferous iron ore containing about 7% of titanium has been smelted directly to steel in the electric furnace on a small working scale in Canada, and the successful utilization of such ores may perhaps be looked for in this direction rather than by smelting in blast-furnaces.

OTHER USES.—The employment of titanium carbide as an electrode for arc lighting has been suggested, but it is not much used for this purpose alone, as the light is of a yellow character, and the operating costs are high. It is stated that this substance gives a high candle-power efficiency. It has been found that the titanium carbide arcs are most satisfactory when operated on a constant current circuit. The electrodes are prepared by grinding the carbide to a fine powder, mixing with a suitable binder and forcing the paste through a nozzle by means of a hydraulic press. The rods so produced are cut into suitable lengths and dried, first in the air, then in a gas oven, and finally in an electric furnace of the carbon-tube pattern. The electrodes are plated with copper to prevent oxidation during burning. The characteristics of the titanium-carbide arc light are an extremely luminous inner path, very little light from the outer mantle, and none from the craters. The carbide is used as the cathode, the anode being a rod of copper or carbon. Electrodes of the sub-oxide of titanium prepared by the reduction of rutile have also been tried for arc lighting, but with no great success. The electrode containing titanium which has been most extensively used is that employed in the so-called "magnetite" arc lamp. This electrode is composed of magnetite, with 15 to 20% of rutile, and some chromite; the first-named giving conductivity to the electrode, the second being the light-producer, and the last adding to the life of the electrode. This lamp, which first found favour in the United States, is now employed to a limited extent in this country. According to English patent 18,220 of 1912 a luminous arc electrode is prepared from a mixture consisting of titanium carbide 96%, copper oxide 3%, and lithium fluoride 1%. Another mixture for this purpose consists, according to United States patent 1,112,458, largely of carbon together with some calcium titanate, an organic salt of titanium and a titanium halogen compound or alkali titano-fluoride. The use of cerium titano-fluoride is covered by English patent 13,988 of 1912. The light is steadied by the addition of potassium or sodium fluoride, and barium fluoride is added to correct the colour of the flame. A mixture for luminous arc electrodes may contain carbon 45%, cerium titano-fluoride 35%, potassium fluoride 10%, barium fluoride 10%. To the mixture is added a small quantity of either silicate, borate, carbonate, tungstate, or molybdate of sodium in order to minimize the etching effect of the fluorides on the glass globes. Titanic oxide mixed with calcium cyanamide, cryolite, and carbon is suggested in English patent 11,792 of 1912. Fused oxides of titanium, tungsten, and rare earths in molecular proportions are suggested in United States patent 1,161,173.

Titanium itself has been suggested and tried to a limited extent as a material for filaments for electric glow lamps, the processes of manufacture and use being covered by numerous patents. It is claimed that such filaments give a high candle-power efficiency, and are less sensitive to variations in voltage than other filaments. A trial lot of about 1,000 of these lamps was produced in America in 1906. A suitable means for the production of such filaments is to force a colloidal solution of titanium hydroxide through a small nozzle, and after drying the fine thread thus produced to reduce it in hydrogen to the metallic state. It is interesting to note that should there be the slightest trace of carbon present in the filament, such as may get in it from the vaporized oil from the pump during exhaustion, the efficiency of the lamp will be so impaired as to be practically useless.

A process for obtaining pigments from titaniferous iron ore such as ilmenite has been described. The ore is roasted at a temperature below incipient fusion and crushed in water, yielding a finely divided product of a yellow to red colour. Light yellow pigments, stated to be suitable for use in rust-preventing paints, are made, according to English patent 10,368 of 1911, by digesting titaniferous iron ore with sulphuric acid and then roasting the mass at a temperature high enough to decompose the sulphates. [More recent patents on this subject have been noted in our issues of May and June.—EDITOR].

Rutile is sometimes added to porcelain tiles to give a soft yellow underglaze colour, and it finds a similar use in the manufacture of artificial teeth. Only the purest varieties can be employed for the latter purpose. Pure titanium compounds, paticularly the oxalate and the double ammonium oxalate, are used to a limited extent as mordants. They are stated to give with tannin a yellow colour of great durability. Titanous chloride has been used as a mordant, and the sulphate as a mordant and stripper. The double pyrophosphates of titanium with the alkali metals are stated to be capable of application to textiles without damage to the latter. The use of titanium salts as mordants for texiles seems limited. Titanium potassium oxalate is used on a fairly considerable scale for staining and dying leather, and it is particularly useful for chrome-tanned leathers, producing shades of colour which are extremely fast to light and alkalis.

Titanous chloride and sulphate are stated to be finding an extended use in the textile industry on account of their great power as acid-reducing agents. Titanous chloride is used in laundries for removing iron stains and for cleaning coloured goods that have run in the wash. Titanium lactates were advertised, before the war, under the name of corichrome as mordants and strikers for use in the leather industry.

It as been suggested that titanium nitride, which is produced during the smelting of titaniferous iron ore, might be utilized as a nitrogenous manure, but experiments do not seem to have been made to test the availability of this compound for the usual agricultural purposes.

LEACHING WITH AMMONIA.

In our issue of May 1915 we gave an outline of a process proposed by C. H. Benedict to treat the sandy tailing at the Calumet & Hecla mine, Michigan, containing native and oxidized copper. The process consists of leaching with a solution of carbonate of ammonia, and both current tailing and the accumulations of old tailing dumped into the lake are being treated. This method has often been tried on copper and zinc ores, but losses of ammonia have hitherto caused unsurmountable difficulties. The plant erected by Mr. Benedict has been entirely successful, and his practice therefore marks an important step in metallurgical treatment. For this reason we quote from his article in some detail, and these notes should be read in conjunction with the article previously published.

An outline of the chemistry of the process is first given. Oxide of copper, or native copper with the free access of air, dissolves in ammonium carbonate to form cupric ammonium carbonate, probably according to to the following reactions :

$$Cu + O = CuO$$

$$CuO + (NH_4)_2CO_2 = CuCO_3, 2NH_3 + H_2O$$

This cupric ammonium carbonate, in the presence of native copper and without free access of air, is reduced to the cuprous state as follows :

$$CuCO_3, 2NH_3 + Cu = Cu_2CO_3, 2NH_3$$

The cuprous ammonium carbonate in the presence of air oxidizes rapidly to the cupric state, and as such is capable of dissolving a further amount of copper. The cuprous or cupric ammonium carbonate, when subjected to boiling or distillation with steam, loses its ammonia and carbonic acid gas, both of which can be absorbed in water and recovered, and as these are driven off, the cuprous or cupric oxide is thrown out of solution either as a heavy powder or as a scale, according to this reaction :

$$CuCO_3, 2NH_3 + H_2O = CuO + (NH_4)_2CO_3$$

The solvents are quantitatively regenerated and the only consumption of a chemical element is that of oxygen from the air. The amount of ammonia remaining in the tailing in practice is small enough to assure the economic possibilities of the process.

It will be observed that the solvent is cupric ammonium carbonate and that this is reduced to the cuprous state in dissolving the native copper. To reoxidize this solution and restore its solvent power, only oxygen of the air is used, and the success or failure of the process depends upon the ability to oxidize the solutions quickly and without loss of ammonia. It is impossible to work entirely in inclosed vessels because to do that would prevent oxidation, and on the other hand to work entirely in open tanks is impractical not only because of the smell and discomfort, but also because it is almost sure to result in excessive loss of ammonia from volatilization. In working with a single tank, as was done in the experimental plant, it is easy to get sufficient oxidation of the solution by superficial action in the storage tanks, for the cuprous solutions have a great avidity for oxygen, and since the cupric salt formed is heavier than the cuprous, convection currents are set up that aid materially in the complete oxidation of the cuprous solutions. It was realized that in a large plant where the effluent solution from one tank would be in storage for only a limited time before being used again as a leaching solution, there would be much less opportunity for oxidation. However, this was worked out as the size of the plant increased, and it has been found a simple matter to oxidize the leaching solutions by blowing air through them and to absorb what little ammonia gas is driven off with the air in a wash solution. This particular feature, which caused the most concern in experimental work, was thus easily met as the plant developed.

The other matter that caused a good deal of difficulty in the experimental work was the " boiling-out " of the solution. The oxide of copper as it was thrown down in the laboratory was a very fine powder which settled rapidly. It was hoped that on a large scale this powder might stay in suspension with sufficient agitation and then settle into a pocket and be easily removed by means of a trap discharge. What was actually found, however, was that while a part of the oxide could be handled by the foregoing methods, part of it which had an opportunity of becoming superheated, as it would above the solution level, formed a scale so hard that it could be removed with nothing short of a hammer and chisel. It became evident that in order to distil this copper ammonium carbonate continuously would require a type of still different from anything on the market, and the author set about making his own apparatus. He started with a still consisting of twelve cylindrical sections, each 15 in. in diameter and 4 in. high and with a vertical shaft extending the full length of the still, fitted with a scraper for each section. The general principle of operation was similar to that of any continuous still, the solution passing downward from section to section against the ascending current of steam. This apparatus demonstrated that any scale of copper oxide formed could be handled by means of these scrapers, and a second still, 36 in. in diameter, was built, followed by the present commercial stills 84 in. in diameter. They have a capacity of over 150 cubic metres per day of copper ammonium carbonate solution assaying about 20 grammes NH_3 per litre, and the same in copper.

The leaching vats in the present building are eight in number and arranged in two rows. Above each row there is an 18 ton travelling crane. The vats are of steel, 54 ft. in diameter and 12 ft. high, and are provided with removable covers. The joint between the cover and the vat is water-sealed and is made by a channel on the cover projecting into a water filled annular launder. There is only one outlet for solutions, and that is in the bottom of the vat, near the centre. On the inside of the vat at the top is the overflow launder, from which there are six outlets. This launder, during the leaching process, has its outlets plugged and is used to form the water seal for the cover, as already indicated. In order to drain the water rapidly from the sand after filling, there are provided two 6 in. decanter pipes. There are seven discharging doors for sands in each vat, six along the sides at the bottom and one in the bottom at the centre. The centre gate is operated from above by means of a rod that extends up through the centre column of the vat. The centre column acts also as a support for the sand distributor, of the Butters and Mein type, which cannot be hung from above, as in the usual leaching vat, because of the clearance necessary for the cover. These leaching vats are carried on 12 in. I-beams which in turn rest on concrete cross-walls of sufficient height to permit ready access to and inspection of all parts of the bottom. The vats are provided also with a platform or runway 3½ ft. below the top, which forms the main working floor. For supporting the sand in the vats a filter grating of wood is provided, and a filter consisting of a lower layer of cocoa matting over which is 8 oz. duck. The cocoa matting and the duck are held in place by calking them with hemp ropes into grooves around the centre gate casting and also around the periphery of the vat. After a year of use the first set of filter cloths and matting are still in commission and show no great evidence of wear.

There are four ongoing solutions as follows: First leach, second leach, first wash, and second, or water wash. There are four corresponding effluent solutions: Rich solution for distillation, new first leach, new second leach, and new first wash. The rich solution, first leach, and the ongoing second leach will all assay about 20 grammes NH_3 per litre, with copper content respectively of about 18 grammes, 12 grammes, and 9 grammes per litre. These assays are subject to some change, depending upon the copper content of the sand and upon the exigencies of operating conditions. The process is controlled by analysis of the copper and ammonia in the leaching solutions, and the aim is to keep these constant. To do this necessitates regenerating by distillation a volume of solution containing copper equivalent to the amount extracted from the sand.

The only solvent required is purchased in liquid form, and thereby some of the difficulties attendant upon dissolving a solid for use as a solvent are avoided. Carbonated ammonia liquor in tank cars is purchased from the Semet-Solvay Co. The amount of carbon dioxide in this liquor is varied at the plant so as to keep the percentage in the leaching solutions about the equivalent of that of ammonia. The contents of the tank car are forced by means of compressed air into the strong-liquor storage tanks and from these run by gravity into the mixing tank at the desired rate for maintaining the ammonia contents of the second leach. All other solutions are made up from the effluent solutions by proper selection and control. If there is any tendency for the volume of any given solution to increase or decrease, or its assay to vary, it can be compensated by varying the amount of solution to be distilled.

The distillation of the rich solution with the recovery of the ammonium carbonate and the precipitation of the copper oxide is carried on in an apparatus analogous to that used in the by-product coke industry for distilling ammonia, with the exception of the still previously described, which was developed for this particular liquor. The plant for this distillation was designed on the spot in connection with the engineers of the Semet-Solvay Co., who furnished all the apparatus except the stills mentioned and their accessories. About 90% of the copper content of the liquor is deposited in this still, which is called a roughing still, and is trapped off into a chamber that is discharged periodically directly into a filter box and from this loaded into concentrate cars. The other 10% of the copper remains in solution or suspension and passes through a second still of a standard type, which is called a finishing still, and from which the final solution, barren of ammonia, runs into a settling tank to permit the settling out of the copper oxide. There are two roughing stills connected in parallel, as to solution and steam, with one finishing still. The oxide of copper as precipitated by this operation will assay about 80% copper and is practically pure. It goes direct to the smelting works, where it is mixed with the native copper concentrate, and as it is free from gangue, it is highly prized by the smelter men, because the oxygen it contains aids in slagging off the impurities of the rest of the charge.

The greatest single item of expense is the ammonia, the loss of which is just under one pound per ton of sand treated. Under ordinary economic conditions this ammonia should not cost over 15c. per lb., but at present, owing to the excessive demand, the cost is almost double that figure. The complete record of cost for March is given in the accompanying table.

Cost of Ammonia Leaching.

	Per Ton
General expense, including foremen and chemists	$0·031
Ammonia	·255
Sand conveying and classification	·020
Labour, power and supplies for leaching	·027
Steam for distillation	·038
Labour and supplies for distillation	·035
Total cost	$0·406

During this month there was a recovery of 8·18 lb. copper per ton of material treated, giving a cost per pound, up to smelting, of just 5c. For the first four months of the year the cost per pound of copper has been less than 4·75c. up to smelting, or about 6c. per pound sold. The present production is at a rate in excess of six million pounds per year.

KIRKPATRICK'S CONTRIBUTIONS TO METALLURGY.

The services of Professor S. F. Kirkpatrick in the treatment of the silver ores of Cobalt are suitably recognized in the *Canadian Mining Journal* for August 1. The award to him of the McCharles prize for 1917 was appropriate, and the brief outline of his work given by S. B. Wright, of the Deloro Mining & Reduction Co., clearly defines the nature of the results of his researches. We quote from the account given by Mr. Wright, as it establishes Professor Kirkpatrick's position with regard to the use of aluminium dust as a precipitant of silver, which was later employed by the Nipissing metallurgists.

Mr. Kirkpatrick carried out an elaborate research in connection with the treatment of cobalt-silver ore at the School of Mining, Kingston, in 1905. The Deloro Mining & Reduction Company, Limited, was formed in 1906 for the purpose of treating cobalt-silver ore, adopting the processes worked out by him. The plant started operating in November 1907. The original process consisted in cyaniding the milled ore direct in conical-bottom agitation vats, the circulation of pulp and solution being performed by means of centrifugal pumps drawing from the bottom of the agitators and delivering on to spreaders at the top. After the necessary clarifying of solutions, the silver was precipitated by means of aluminium dust, fluxed, and melted down to commercial bars 996–999 fine. The ore residue after cyaniding was smelted to a speiss for the extraction of the remaining silver and of the cobalt, nickel, and arsenic contents.

Subsequently, in 1908, on account of the variable nature of the ores handled and of the uncertainty of their amenability to cyanide treatment, the direct smelting of the ore was adopted. This produced a speiss containing much higher silver contents, but process losses did not increase. The treatment of the speiss, whether low or high in silver, consists in roasting down to 10% As, and lower, in mechanically rabbled furnaces, chloridizing this roast speiss with salt in muffle furnaces, and cyaniding the product. This treatment of a chloridized speiss by cyanide was undoubtedly an entirely new departure in metallurgy, and as its success was dependent on the use of aluminium as a precipitant, this part of Mr. Kirkpatrick's processes has been of the greatest importance. Particularly so in view of the fact that on account of the restricted market for cobalt, it was necessary to have a method of extracting the bulk of the silver values without putting heavy costs on the cobalt contents which might have to be stored for a long time. This method of treatment proved satisfactory, and has been carried on from the start.

At Deloro, one part by weight of aluminium precipitates eight parts of silver. With solutions less rich in silver than those obtained in this practice, a slightly lower efficiency is naturally expected (for instance, the Nipissing Co.'s low-grade mill practice); but the regeneration of the cyanogen combined with the silver in solution comes up the theoretical figures in all cases. This regeneration is of the utmost importance, as it would enable aluminium to compete with zinc at normal prices even if there were no other advantages, the regeneration of cyanide in the case of zinc being practically nil. A further important advantage of aluminium, however, is the fact that by means of a simple melting operation without any subsequent refining, silver bullion 996–999 fine is produced, all further refining charges being this obviated. As the refiners' charges on all bullion below 996 fine and on brittle bullion range from one-quarter cent per ounce up, it will be seen that this point is of great importance in the matter of costs.

Quite apart from the advantages already mentioned, it is a fact that in attempting to apply zinc as a precipitant to the cyanide solutions used on cobalt-silver ore, the solutions become foul so rapidly that the cyanide treatment would be commercially unsuccessful. This was proved in the case of the Nipissing Co.'s low-grade mill, which was originally designed for zinc-dust precipitation, but was eventually changed to aluminium dust.

The first plant in Cobalt to treat low-grade ore by the cyanide process successfully was that at the O'Brien mine, which adopted Mr. Kirkpatrick's aluminium precipitation and the general treatment advised by him. Since that time a large quantity of silver has been produced in Cobalt by this process. The output of the Deloro Mining & Reduction Co.'s plant from 1906 to the present time has amounted to approximately 40,375,000 ounces of silver, of which about 50% has been produced by aluminium precipitation.

In the extraction of the cobalt and nickel from the ore by the processes worked out by Mr. Kirkpatrick, the following figures of output at the Deloro works are interesting :

	lb.
Cobalt (metal), in form of oxides, metal, etc.	1,168,491
Nickel (metal), in form of oxides, metal, etc.	371,747
Arsenic (white)	15,646,258

The cobalt oxides produced are of the highest grade, the black oxide being guaranteed to contain 70% cobalt. In 1915 the production of cobalt and nickel metals was started in the works, which are now able to produce cobalt metal in the forms required by the market, at the rate of about one ton per day.

In the extraction of the cobalt and nickel from the speiss residue Mr. Kirkpatrick's first aim was to get away from the old hydrochloric acid treatment, with its attendant difficulties. This he succeeded in doing by sulphating the residue with H_2SO_4, rendering the bulk of the iron insoluble by roasting, and eventually obtaining a neutral cobalt-nickel sulphate solution from this material. By the methods employed, the question of corrosion of plant by acid solutions, etc., is practically overcome, and it is possible to use wooden tanks and iron pipe systems throughout.

The operations of the Deloro company have enabled the Cobalt mine owners to obtain far higher prices for their ore, for they were at the mercy of the United States smelters until it came into the field.

Iron Ore in the Lias.—The Lias and Oolite iron ores are worked more extensively in England than is commonly supposed, and during the past year the Ministry of Munitions has taken steps to increase the output. The mines extend from North Yorkshire through Lincolnshire, Northampton, and Leicester, and there are other workings at various places farther south-west in Oxfordshire and Wiltshire. Recently the deposits near Dover have assumed economic importance. In the *Journal of the Society of Arts* for August 10, E. A. Walford writes on the Oxfordshire deposits, which belong to the Middle Lias.

The calcareous ironstone of the Middle Lias in North Oxfordshire attains its best development in the neighbourhood of Banbury. The outcrop is along the ridge of high land bordering the northern part of the county, and the maximum thickness is about 30 ft. It is on the same horizon as the Lias ironstone of Cleveland, in North Yorkshire. The field covers the greater part of North Oxfordshire, extending as far southwards as Great Tew and Fawler, near Woodstock. The three seams which make up the rock mass vary considerably in their composition; the upper, the "road stone" seam, is a hydrated ferric oxide, yielding 33% of iron in good localities. The underlying "rag" seam has six or seven beds of blue-green oolitic stone with red stone partings, bearing a lower percentage. The "bottom stone" seam yields 3 ft. of stone of a lighter texture, an oolitic green carbonate with joints, partings, and coatings of red stone. The higher, the road stone beds, make up about 10 ft., the middle beds about 6 ft., and the bottom stone about 4 ft. of the ordinary quarries; but with the bottom stone should be placed about 3 ft. of red "oven" stone separating the middle seam from the lower beds. It appears, from investigations made by the writer, that the stone was originally a calcareous *remanie* of a deep sea-floor, a tangle of crinoidal life accumulated in successive stages of growth, while occasional periods of parasitic growth of mollusca patched and banded the tangle into the Lias limestone, which long periods of time, and decay of overlying strata, charged with iron mineral. Considerable differences in the structure of the stone are met with in its range of twenty miles north to south, and twelve miles east to west. At Edge Hill and Hook Norton there are beds 6 in. or more in thickness of ferro-crinoid stems. At Astrop and Byfield the upper seam is largely composed of small crinoid segments, which are spread throughout a series of thin beds. Bands of shells of brachiopoda are persistent in the middle and upper courses, and clustered masses of Rhynchonella and Terebratula are scattered throughout the rock mass. The Edge Hill quarries have been worked for an excellent building and paving stone from long distant time. Its mineral exploitation is now being taken up with that of the southern area. Extensive workings at Adderbury, Astrop, Hook Norton, and Byfield, with steam shovels and numerous calcining furnaces, have been carried on for many years.

The gradual fall of the surface and rock from the Edge Hill area toward Banbury (that is, from about 700 ft. altitude to 350 ft.) presents conditions favourable to mining enterprise certainly equal to that of the sharp fall of the surface from the escarpment ridge to the Kineton plain, a plain traversed from east to west by the East and West Junction railway. The nearness of the Warwickshire coalfield should also aid in the development of the area which the several new companies are beginning to exploit. One of these is the Oxfordshire Ironstone Co. The whole field almost is drained by the effluents of the River Cherwell. The grounds of the Nen in Northamptonshire are covered by Upper Lias and Inferior Oolite, bringing in, as they fall eastward, the Northamptonshire iron ore to which the Lias is often now conveyed from the mines near the Oxfordshire border. The calcareous type, and perhaps more open structure of Lias stone, is said to help the smelting of the Inferior Oolite ore. Why the Lias stone should dwindle, disappear, or lose its ferruginous condition with the Nen drainage is not yet open to our knowledge. In an "Account of the Geology of the Brackley Town Well," printed in the *Buckingham Advertiser* in 1912, the writer pointed out the complete removal of the Lias ironstone series as well as the thick limestones above the Inferior Oolite. The Middle Lias is not the only calcareous bed which vanishes with the high lands of the Nen ; one of the greatest of the sub-Bathonian rocks (the equivalent of the Lincolnshire limestone) is wholly removed. It also makes an excellent ironstone to the north-east. Open-cut mining is now conducted by the Adderbury Ironstone Co., the Astrop Ironstone Co., the Bloxham Ironstone Co., the Brymbo Iron and Steel Co., the Baker Co., and Earl Dudley's at Hook Norton. On the contiguous Northamptonshire border are workings at Byfield by the Northamptonshire Ironstone Co., and another company at Charwelton.

The Murex Process.—We described the Murex magnetic concentration process, the invention of A. A. Lockwood, in our issue of October 1909. By this method sulphide and carbonate ores are mixed with water, oil, and magnetite. The magnetite and metallic minerals are caused to adhere by the action of the oil. The pulp is passed along launders under magnets, which remove the magnetite and its adhering metallic mineral. The process is at work at the Cordoba Copper Co.'s mine in Spain, but otherwise its application has not been extensive. For some time it has been the subject of experiment at the Darwin lead-silver mine, Inyo county, California. A 25 ton plant has been tested, and has just been duplicated. In the *Engineering and Mining Journal* for July 14, H. S. Rexworthy, the manager, gives some particulars of the application. The ore is very variable, both the metallic minerals and the constituents of the gangue being irregularly distributed. Among the metallic minerals are lead carbonate, galena, horn silver, and native silver, and the gangue consists at different places of jasper, quartz, calcite, oxides of iron, etc. The ore is ground to 20 mesh. The pulp is sent to horizontal cylindrical agitators where oil and magnetite are added. The cylinders are 10 ft. long and 3 ft. in diameter. They revolve slowly, and contain several hundred pounds of ¼ in. iron or steel punchings. These punchings become coated with the mixture of oil and magnetite, and the lead minerals are caught on their surfaces. The continual rolling removes the mixture, which then passes along shaking conveyors underneath an electromagnet. The oil used is a crude petroleum or a petroleum residue, the amount being from ¾ to 1½% of the ore. A small amount of oleic acid may be added. The cost per ton of ore is given at \$1·78, made up as follows: 15 lb. oil at 1·43 cents per lb., 21½c. ; 17 lb. magnetite at 1·2c., 20½c. ; 0·8 lb. oleic acid at 15c., 11¼c. ; labour, 3 men at \$4·00 per day, 75c. ; power and water 50c.

Copper Deposits of Namaqualand.—A paper was presented by F. W. Jenkins at the August meeting of the North of England Institute of Mining and Mechanical Engineers on Little Namaqualand and its future possibilities as a copper-producing country. Port Nolloth, the entrance to Little Namaqualand, is situated about 300 miles from Cape Town on the west coast of Africa. It is the only port on the coast, and is served by lighters and tugs. There is a railway, 120 miles long, which runs inland east and south-east. For this enterprise credit is due to the Cape Copper Company, one of the early pioneers. The operations of early prospectors extended from Port Nolloth, north, south, and east of the Orange River. These enterprises were not attended with much success for many years, although copper stains were abundantly found in the various rocks, grey granite and schists. The population consisted of bushmen and hottentots, and the difficulty in finding labour, transport, etc., was no doubt a great drawback to persistent and methodical prospecting at any depth. However, the result was that two rich copper mines were finally discovered, the O'Okiep and the Tweefontein.

The O'Okiep in the ten years from 1883 to 1904 produced 534,626 tons of copper ore containing an average of 20·2% copper. This deposit was discovered by a bullock cart disturbing the surface of a hill. Falling into good hands, the surrounding district was exploited so successfully that in a few years a great mining industry was established. In the neighbourhood are such mines as Spectakel, Nababeep, and O'Okiep East, which were also opened with good results. Spectakel in the same 10 years (1883 to 1904) yielded 19,636 tons of high-class ore averaging 31·85% copper ; Nababeep 114,332 tons averaging 6·16% ; and O'Okiep East 19,022 tons averaging 5%. The Namaqua Copper Co. also proved the value of Namaqualand as a copper-producing district, for the Tweefontein produced 138,683 tons containing 25·4% copper in the same 10 years. The Flat mine yielded 5,000 tons of 20% copper, and the Hester Maria 3,500 tons of similar grade. Some of these properties, such as O'Okiep, are not now producing as much ore as formerly, but the ore in O'Okiep is being used as a flux for smelting.

Outside of these two properties little or no work in the way of prospecting in Little Namaqualand has been accomplished. Near the Orange River in the north-east corner two prospects yielded a considerable quantity of high-grade ore, namely, the Numees and Kodas mines. Adits and levels have been driven and shafts sunk, but owing to the want of technical knowledge, capital, and transport facilities the mining has not been continued. The transport overland would be 100 miles partly over sand-dunes, or by way of the Orange River six miles away, but the river has insufficient depth of water at most seasons. As soon as a suitable ore deposit is opened up the Government proposes to facilitate transport by building a railway.

Professor A. W. Rogers in his presidential address to the Geological Society of South Africa in 1916 upon the nature of the copper deposits of Little Namaqualand, stated that the copper-bearing rocks of Namaqualand fall into two clearly defined groups : (1) those which occur in veins of quartz, carbonates, felspar, and chlorite ; and (2) those associated with the igneous intrusions in gneiss. The first group is found in the northern portion, but has not been much exploited, and has not so far given much output of copper. Gneiss is so far the copper yielder, as at O'Okiep and Concordia.

Mr. Jenkins expresses the belief that Namaqualand, with the assistance which is now forthcoming from the South African Government, will prove to be one of the largest and most successful copper regions in the British Empire.

Formation of Zinc Ferrate.—The *Bulletin* of the Canadian Mining Institute for July contains a paper by E. H. Hamilton, G. Murray, and D. McIntosh on the formation of zinc ferrate during the roasting of complex zinc ores. The authors are connected with the Consolidated Mining & Smelting Company of Canada, and their work has been done in connection with the lead-zinc ore from the Sullivan mine in British Columbia. When pyrite is present in such ore it is often found that, after roasting, some of the zinc is insoluble in water or sulphuric acid, thus indicating that it does not exist as oxide or sulphate. Records on this subject are found in Ingalls' "Metallurgy of Zinc," in a paper by Hofman in the Transactions of the American Institute 1905, in a paper by Wells in the *Engineering and Mining Journal* Vol. 86, the second half of 1908, and elsewhere. The present authors conducted a number of experiments with a view to ascertain the formation of compounds of zinc oxide with iron oxide and with alumina. We give their conclusions herewith.

It is proved that zinc oxide and ferric oxide will combine readily at temperature above 1,200° F., the amount of combination depending principally on the temperature and the time. In the roasting of the ore in the Wedge furnaces, however, in order to desulphurize the ore sufficiently, it is not possible to keep the temperature down to a point at which the formation of ferrate does not occur. In the upper part of the furnace especially, it is difficult to keep the ore from becoming too hot owing to the large amount of sulphur present, but it is possible that, by decreasing the frequency of the rabbling, ore might be kept for a longer period in the furnace and subjected to a lower temperature, as the more rapid the stirring while the sulphur is burning readily the higher the temperature attained. In connection with this, in the case of the Sullivan ore as at present roasted, the maximum amount of ferrate seems to be formed at 1,200° F., as some of the regular roast was heated to a temperature of 1,500° for 5 hours and the extraction on this material was no worse than on the original. Free alumina combines with zinc oxide, but when present as a silicate the amount of combination is negligible. There are four ways in which a better extraction of zinc might be obtained from an ore high in iron: by roasting at a low temperature, by eliminating the iron before roasting, by the addition of some substance to the ore which would prevent the combination of the two oxides, by finding some solvent for the zinc which would leave the iron oxide undissolved.

Standard Screens.—The *Bulletin* of the American Institute of Mining Engineers for June contains a paper entitled: "A Standard Screen Scale for Testing-Sieves." This paper is to be discussed at the St. Louis meeting in October. It contains the suggestions of representatives of various societies and other institutions for the establishment of standard screens. The series is based on a screen with 1 millimetre opening. The openings of the coarser screens are in the ratio of the square root of 2, and of the finer screens in the ratio of the fourth root of 2. The diameters of the wires are not equal to the width of the openings, but are properly graded so as to avoid unnecessarily thick wires for the coarser screens. The system is based on the principles advocated by us in the issue of November 1915, and consequently we recommend readers to pay close attention to the paper.

Treatment of Porcupine Ore.—The *Bulletin* of the Canadian Mining Institute for August contains a paper by A. Dorfman on metallurgical practice at the McIntyre gold mine, Porcupine. At first the ore was passed over amalgamating plates, and the pyritic material extracted on tables. In the course of experiments in connection with the cyaniding of the table tailing, it was found advantageous to all-slime the ore and discard the amalgamating and concentrating. The ore is now reduced in Hardinge ball-mills and pebble-mills to minus 200 mesh.

Transvaal Iron Ores.—In the issue of July 14, the *South African Mining Journal* commences the publication of a report made by P. A. Wagner and G. H. Stanley for the Pretoria Municipality on the geology of the iron ore deposits on the Pretoria Townlands. We shall give an outline of the report in a subsequent issue.

Hammer-Drills.—August *Bulletin* of American Institute of Mining Engineers. C. R. Forbes and J. C. Barton. Comparative Tests of Hammer-Drill Bits, including the cross-bit, 6 point bit, Z bit, and Carr bit.

Drill Steel.—In the *Engineering and Mining Journal* for July 28, G. H. Gilman gives information supplementing his article in the issue of May 12, in connection with the methods of sharpening and tempering drill bits.

Hancock Jig.—August *Bulletin* of American Institute of Mining Engineers. H. Rabling. The Hancock Jig in the Concentration of Lead Ores, referring to results obtained at the Bonne Terre mill of the St. Joseph Lead Co., Missouri.

Storing Tailing.—August *Bulletin* of American Institute of Mining Engineers. F. E. Marcy. A plea for the desirability of preserving tailing on the chance of subsequent discovery of means of treatment.

Tungsten-Gold Ores.—August *Bulletin* of American Institute of Mining Engineers. R. R. Goodrich and N. E. Holden. Treatment of tungsten-gold ore at Golden Chest mine, Murray, Idaho.

Concentrating Tungsten Ores.—In *Metallurgical and Chemical Engineering* for July 15, Dr. S. Fischer gives the second part of an article (the first appeared in the issue of May 15) describing concentrating plants at a number of tungsten mines in Colorado.

Salt in Lead Metallurgy.—August *Bulletin* of American Institute of Mining Engineers. O. C. Ralston, C. E. Williams, M. J. Udy, and G. J. Holt. Details of experiments on processes for the treatment of oxidized lead ores.

Assaying Cyanide Bullion.—The July *Bulletin* of the American Institute of Mining Engineers contains a paper by F. P. Dewey on the influence of the presence of base metals such as zinc, cadmium, copper, lead, and silver on the results of assays of gold bullion, especially cyanide bullion.

Metallurgy of Ferro-Chromium.—R. J. Anderson. *Engineering and Mining Journal*, August 11.

Zinc Retort Practice.—In *Metallurgical and Chemical Engineering* for August 1, E. M. Johnson, superintendent of the Eagle Picher Lead Co., writes on operating details of zinc furnaces, describing and illustrating the various tools and their uses, and the daily practice.

Silver Ores.—*Economic Geology*, June, F. N. Guild. Microscopic Study of Silver Ores and their Associated Minerals.

Replacements of Minerals.—The June *Bulletin* of the American Institute of Mining Engineers contains a paper, by H. N. Wolcott, describing a case of replacement of iron-copper sulphides by quartz, at the Old Town Mine, Colorado.

Monazite Sand.—In the *Engineering and Mining Journal* for July 28, D. M. Liddell describes the ilmenite-monazite sand on the sea-shore near Jacksonville, Florida. The sand is raised by suction dredge and concentrated on tables, then the ilmenite is removed magnetically, and the concentrate tabled again to separate the monazite from rutile and zircon.

Norwegian Copper Ores.—August *Bulletin* of American Institute of Mining Engineers. H. Ries and R. E. Somers. The Pyritic Deposits near Roros, Norway.

Manganese in Queensland.—*Queensland Government Mining Journal* for June. B. Dunstan. Occurrences of manganese ore in Queensland, with notes of minerals, markets, and uses.

Miami, Arizona.—T. A. Rickard has recently visited the Arizona copper regions. In the issue of the *Mining and Scientific Press* for August 4, he commences a series of articles on Miami.

Natal Coalfields.—The May *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa contains a historical account of the development of the Natal coalfields by W. F. Heslop. An interesting feature of these deposits is the occurrence of dolerite sills, which in many places have converted the coal to anthracite.

RECENT PATENTS PUBLISHED.

2,404 and 2,405 of 1916 (100,092 and 100,171). R. B. LLOPART, Cordoba, Argentine. Improved method of producing a white pigment, lithopone, by reacting with a solution of barium sulphide on a solution of zinc sulphate, producing a mixture of barium sulphate and zinc sulphide. The patent also shows a method of treating the mixture for the production of the pigment.

5,989 of 1916 (108,164). AMERICAN ALLOYS CO., Newark, N.J. An alloy of the nickel-chromium type containing not over 55% nickel or cobalt, not over 30% of chromium, and smaller amounts of silicon, copper, tungsten, titanium, boron, manganese. This alloy resists temperatures of 3,000° F, and is not attacked by any acid except hot aqua regia.

7,468 of 1916 (107,401). E. EDSER, H. L. SULMAN, and MINERALS SEPARATION, London. In the agitation-froth process of concentration by flotation, when the gangue consists of calcite, kaolin, slate, etc., adding a silicic acid sol, which may be formed conveniently by the action of sulphuric acid on sodium silicate.

9,183 of 1916 (107,426). A. R. LINDBLAD, Ludvika, Sweden. Producing potassium or sodium cyanide by mixing felspar with lime and carbon, and treating in the electric furnace.

9,418 of 1916 (107,640). A. H. COWLES, New York. A process for treating felspar and other silicates for the recovery of potash aud alumina.

12,310 of 1916 (107,474). METALLURGICAL COMPANY OF AMERICA, New York. Improvements in the Dwight-Lloyd sintering plant, whereby various supplies of gaseous fuel can be employed according to their availability.

12,368 and 16,198 of 1916 (107,866). T. M. STOCKER, St. Austell. Improved kiln for drying china-clay.

13,238 of 1916 (101,549). W. HOMMEL, Zurich. Improved form of rabble for longitudinal roasting furnaces, the object being to prevent the accumulation of material at the sides of the furnace.

15,260 of 1916 (101,978). C. J. G. AARTS, Dongen, Holland. Oxidizing zinc sulphide to sulphate by heating with air under pressure.

18,450 of 1916 (107,927). W. W. RICHARDSON. London. A system for classifying and concentrating ores, intended for the treatment of alluvial deposits.

NEW BOOKS

Silver: Its History and Romance. By Benjamin White. Cloth, large octavo, 350 pages, illustrated. Price 21s. net. London: Hodder & Stoughton.

The author of this book, Mr. Benjamin White, is associated with the firm of Samuel Montagu & Co., and has been connected with the London silver market all his business life. He does not dismiss silver from his mind at the end of office hours, but makes it his hobby and recreation also. He has sought information about silver in every imaginable direction and from a great variety of sources. As some phases of the subject are more familiar to the author than others, it is natural that the various sections of the book are of unequal value. A mining engineer will pass over the chapters on the sources of silver and methods of extraction, but he will be attracted to the chapters on subjects in which the author is a specialist, that is to say, the marketing and distribution of refined silver, the history of silver coinage, and the records of silver prices. The manner in which the subject is treated is easy and light, and no attempt is made at profundities or technicalities.

The first few chapters are devoted to a history of the use of silver, and of the sources of ore in various parts of the world. Then come sections describing methods of assay and the refining of bullion. The uses of silver, other than for coinage, are treated briefly, with information relating to plate, the beautiful wrought ornamental work of days gone by, the Japanese silver ware, and the industrial and surgical uses of the metal. The minting of coins, the London silver market, and the travels of refined silver are dealt with at some length. Subsequently the author treats the general subjects of money, currency, and coinage, and gives information relating to the Indian and Chinese conditions as regards silver. Other chapters are devoted to silver and the war, bimetallism, and silver in literature. The author's references in the last-named chapter might be expanded indefinitely, and they should include Sir Walter Scott's account of the transactions between King James and George Heriot over a beautiful specimen of Benvenuto Cellini's work, a huge salver, which by orders of the philistine Duke of Buckingham was subsequently rolled back to the city on its edge like a cart wheel. To sum up our opinion of the book we may say that it is full of fascinating facts and that a reader may open it at any page and find his attention immediately arrested. Finally, mention ought to be made of the excellent series of illustrative photographs with which the book is embellished.

The section on the London silver market contains a good deal of information not generally known except to those engaged in the business of buying or selling, and we may therefore extract a few of these paragraphs.

For several generations four firms have formed the market, namely, Messrs. Mocatta & Goldsmid, Samuel Montagu & Co., Pixley & Abell, and Sharps & Wilkins. The first-mentioned firm dates back to 1684, ten years before the Bank of England was founded. In the case of the second firm, silver forms but one branch of their business, for they are also foreign bankers. The operation in London, commonly called "fixing" the price of silver, controls the price of the metal in every important financial centre throughout the world. This official quotation is cabled abroad instantly by the agency of the press, as well as by each of the four firms to such of their foreign clients as desire the information. The great bulk of the business transacted is based upon this price, which is determined at a certain hour each day, namely, 1.45 p.m. (Saturday 11.45 a.m.), by the partners of the respective firms who meet at the office of one of their number. Before the demonetization of silver by Germany in 1873, and the great fall in price which followed that event, the fluctuations as well as the volume of business transacted each day were so small that the operation of "fixing" was carried out by an informal change of notes or by verbal messages. Each broker, while he may disclose the excess of his own position as a buyer or a seller at a given price, is careful to protect in every possible way the interests of his clients, and to preserve their anonymity. It should be remembered that it is quite possible for the business done in the market upon a given day to be extremely large, and yet the amount changing hands at "fixing" to be trifling. Clients are therefore well advised to give a discretion to brokers as to the quantity of silver in which it is desirable to operate for their account upon ony one day. It may be taken for granted that, as a general rule, no silver is parted with at any price before the official quotation is made, but after "fixing" it may occasionally change hands at a lower price if the market is weak, or at a higher if buyers appear after supplies have been absorbed.

The method of fixing the price is very simple. The first step is usually to ascertain if there is occasion to alter the price of the day before. If supplies prove insufficient to satisfy buying orders, higher prices are suggested until the offerings balance the demand. As a rule, two prices are agreed upon at "fixing," one for a cash delivery, which implies delivery within seven days, at the option of the seller, and the other for delivery in two months' time, that is to say, exactly after two calendar months' interval. A period of two months is selected because it is found the most convenient interval at which smelters can undertake to deliver the silver which they have purchased in the form of ore. These two periods of delivery, cash and two months, are obligatory as between brokers, but brokers can, as a rule, make arrangements with their clients so as to suit the latter's convenience with regard to shipping, etc. It should be remembered, however, that any request on the part of a client for arrangements differing widely from brokers' rules as between themselves, may involve expense to the broker in loss of interest, etc., and also some risk of failure to keep engagements which he has contracted with another broker in order to execute his client's business.

The difference, if any, between the price of forward delivery and that for cash depends upon several circumstances. A strong demand for delivery ahead can carry the forward price to a premium, equal to the loss in interest which would be incurred by paying for the silver at once, and holding until the due date; or, on the other hand, an absence of such demand and pressure to sell can bring about a very heavy discount upon the price for silver deliverable within a week. In the former case the premium is limited to the rate of interest, but in the latter case, the only check to the amount of discount is the view taken by the market as to the future prospects of silver. This matter of delivery is of extreme importance to all who operate in silver. Sales for forward delivery, appearing safe and reasonable at the time when they are made, may yet involve extremely serious losses to the seller, owing to causes beyond his control. For instance, a smelter may sell 100,000 ounces for delivery in two months, and a strike may break out, or his consignment of ore may be delayed either in shipment or process just when the market happens to be denuded of spot supplies. Or a bank may buy a quantity of Eastern exchange bills payable in silver, and may sell a quantity of silver as a "hedge." When the paper is redeemed by the drawee in silver, and the bank may desire to buy back the silver, the market may prove unfavourable through circumstances quite beyond its control. Against the risk of such losses may be set off opportunities of gain which may occur. It is possible for dealers in forward silver to obtain a profit by a saving in interest, or on account of an alteration in the relation of the prices fixed for the two deliveries. In other words, a holder of silver for forward delivery may find it advance from a discount to a premium. The existence of a price for forward delivery is necessarily an incentive to speculation, but its chief utility is to afford to smelters, and to the Eastern exchange banks, or to merchants connected with China trade, facilities to carry out their legitimate operations. By legitimate, it is desired to denote operations which are germane to the discharge of their ordinary commercial business. In normal times, cautious speculation in silver is a useful feature of the market. There are sometimes periods when the silver market falls into the doldrums, and acute operators, who may have special means of gauging the situation, are quite justified in taking supplies off the market when it is temporarily overburdened, and giving out when it is short of stocks.

The remuneration of brokers consists of $\frac{1}{8}$%, which is paid by the buyer. Silver is sold free of charge, and thus only a mere 2s. 6d. per £100 separates the buyer from the seller. As between brokers themselves, the brokerage is divided, that is to say, a broker sells to another plus $\frac{1}{16}$%, and buys from another plus $\frac{1}{16}$%. Business is done occasionally in "options," which are based, as a rule, on the forward price. Demand for accommodation of this character is fitful, and is usually a symptom of speculative interest. In the ordinary way this method does not enter into the normal business life of the market. The period fixed is usually for two months, but sometimes an arrangement is made for three to six months, rarely for longer. When no wide fluctuations are expected, an option for two months to "call" or "put" silver costs about 2% of the price, plus a brokerage of $\frac{1}{8}$% calculated upon the value of the silver. To give a concrete illustration, when the price of silver for forward delivery is fixed at 24d. per ounce standard, and it is desired to buy the "call," or an option of demanding at the end of two months from the date of the contract, £10,000 worth of bar silver at 24d. per standard ounce against payment of £10,000, the outlay would be £208. 6s. 8d., plus £12. 10s. brokerage. The reverse operation, the "put," or the right to compel the grantor of the option to accept silver at basis price, would cost the same sum.

COMPANY REPORTS

Dolcoath.—The report of the premier tin mining company of Cornwall for the half-year ended June 30 shows that 35,174 tons of ore was raised yielding 500 tons of concentrate, or 31·85 lb. of concentrate per ton of ore. The income from the sale of concentrate was £62,889, and the average price obtained per ton was £125. 15s. The total receipts were £64,309, the working cost was £55,828, the lord's royalties £4,203, and the working profit £4,356, out of which £2,524 has been written off for depreciation. For many years this mine made profits and paid dividends, but in 1914 the poor developments at depth caused a restriction of output and a decrease in the yield per ton. The restriction of output was also partly governed by the scarcity of labour. During the last few half-years losses have alternated with profits. The amount of development work now possible is small owing to lack of men. R. Arthur Thomas, the manager, reports that exploration on the 440 fm. level east of New East shaft has opened up useful reserves. Diamond-drilling has been conducted from various points, but no definite announcements are made relating to results.

Tincroft Mines.—This company was formed as the Carn Brea & Tincroft Mines in 1900 to acquire tin mines near Camborne, Cornwall, that had been worked for many decades under the cost-book system. We have on many occasions referred to the fortunes of the limited liability company, recording the difficulties of making a working profit owing to the low-grade of the ore and the want of facilities for introducing modern mining and metallurgical methods. Two years ago the Carn Brea section was abandoned, and shortly afterward the capital was written down and the name changed. The report for the half-year ended June 30 shows that 27,374 tons of ore was raised, and that the yield of tin concentrate was 233 tons, selling for £27,692. The yield of tin concentrate per ton of ore was 19 lb. The sale of white arsenic brought an income of £12,008, and of wolfram concentrate £2,503. The net profit was £3,565, as compared with a loss of £1,190 during the previous six months. The directors propose to issue the remaining 11,393 priority shares of 5s. each, in order to enable them to discharge the bank overdraft.

Cornwall Tailings.—This company was formed in 1910 to buy old tailing heaps from the Carn Brea & Tincroft Company, at Camborne, Cornwall. The control is with the Lempriere-Lionel Robinson group, and the work was undertaken at the recommendation of Arthur Richards, who is managing director. The report for the year ended February 28 last shows that 124,471 tons of tailing averaging 12·92 lb. metallic tin per ton was re-ground and concentrated, for a yield of 376½ tons of tin concentrate. The percentage of recovery was 34·48. During the previous year the assay-value was 13·55 lb., and the percentage of recovery 31·55. The concentrate sold for £32,772, and after allowing £2,000 for depreciation, the profit was £3,029. Adding this to the balance brought forward from the previous year, £4,077, the distributable profit was £7,106. Out of this, £4,040 has been distributed as dividend, being 10% less income tax. The cost of treatment was 4s. 2d. per ton, as compared with 3s. 9d. the year before, and at the time of writing the report, July 20, the cost had gone up to 5s. per ton. The amount of tailing still remaining is about 400,000 tons, but most of this is of too low a grade to be profitably treated, and even with the present high price of tin, it is not probable that operations can be continued for many more months.

Leadhills.—This company was formed in 1903 as a reconstruction of a company formed in 1876 for the purpose of working silver-lead mines at Leadhills, Lanark, Scotland. Smelting was discontinued in 1905, and the concentrate is now sold. At the time of reconstruction the par value of the shares was written down from £6 to £1. During the years 1876 to 1903, dividends amounting to 50% on the capital, £120,000, were distributed. From 1903 to 1917 the distribution has totalled 250% on the reduced capital, of which £17,045 is issued. The report for the year ended June 30 shows that 1,874 tons of lead concentrate was sold, realizing £38,025, and that, after £8,625 had been allocated for income tax and excess profits duty, the profit was £4,624, out of which £3,409 has been distributed, being at the rate of 20%. During the year, additional modern plant has been erected in the power house and dressing floors. The manager, W. Bawden Skewis, writes favourably of developments.

Wanderer (Selukwe) Gold Mines.—This company was formed in 1899 to acquire the Wanderer, Ashton, and other gold mines, in the banded ironstones of the Selukwe district of Rhodesia. Edmund Davis is chairman, and Noel Griffin is the consulting engineer. The ore is of low grade and is amenable to direct cyanide treatment. The capital was originally £450,000. In 1909 the par value of the £1 share was written down to 5s., and additional shares issued. In April 1915, £60,000 was distributed among shareholders as a return of capital, and the 5s. share was reduced to 3s. Shortly afterward, £15,000 was distributed as dividend, being at the rate of 16⅔%. The report for the year ended April 30 shows that 164,700 tons of ore was raised and treated, for a yield of gold worth £71,087, or 8s. 7d. per ton. The working cost was £47,747, or 5s. 9d. per ton, leaving a working profit of £23,339, or 2s. 10d. per ton. After allowing £2,845 for depreciation, £1,944 for income tax, and £1,408 for London expenses, a net profit remained of £17,349. Adding this to the balance brought forward from the previous year, the distributable balance was £34,776. Out of this, £30,000 has been paid as dividend, being at the rate of 33⅓% on the reduced capital. The mines have continued to yield ore to a greater extent than expected, and in particular the Wanderer South has done well. The reserves at the various mines on April 30 were estimated at 60,000 tons. The future will depend on results of current development.

Associated Gold Mines of Western Australia.—This company was formed in 1894 to acquire the Australia and other leases at Kalgoorlie. During the years 1898 to 1909, dividends totalling 150% on a capital of £500,000 were distributed. Subsequently the fall in the grade of the ore has resulted in alternate small profits and losses. The report for the year ended March 31 shows that 93,430 tons of ore, averaging 27s. 5d. per ton, was treated, for a yield of gold worth £124,611. The net profit was £5,544. The year commenced with a debit balance of £9,024, and ended with a debit balance of £3,480. The cash assets of the company consist of £60,000 Transvaal Government 3% Stock. Other assets are shares in the Associated Northern Blocks, the Huronian Belt, and the North Thompson companies, and the Keeley mine option, with a total nominal value of £92,734. D. F. McAulay, the manager at Kalgoorlie, is not able to give any estimate of reserves The reserve of broken ore is 11,653 tons averaging 26s. 10d. per ton. Judging by previous experience, current development may be expected to provide further substantial amounts of ore. As regards the Canadian interests, the North Thompson company, at Porcupine, has been absorbed by the Vipond ; no work has been done on the Keeley options.

South Kalgurli Consolidated.—This company was formed in 1913 as an amalgamation of the South Kalgurli and Hainault companies operating at Kalgoorlie, West Australia, neither of them having been a big dividend payer. The amalgamation was effected for the purpose of conducting joint exploration. The report for the year ended March 31 shows that 110,333 tons of ore yielded gold worth £125,550 for a profit of £4,050, out of which £3,125 has been distributed as dividend, being at the rate of 2½%. The ore reserve is estimated at 133,221 tons averaging 5¾ dwt., a fall of 21,000 tons during the year.

RAND MINES, LIMITED.

Directors: E. A. Wallers (*Chairman*), F. G. J. Eckstein, W. Mosenthal, Sir Lionel Phillips, E. J. Renaud, F. G. C. E. Robellaz, R. W. Schumacher. *London Committee:* J. L. Bergson, F. Heim, T. J. Milner, L. Wagner. *Secretary:* S. C. Steil. *Office:* Corner House, Johannesburg. *London Office:* 1 London Wall Buildings. *Formed* 1893. *Capital* issued: £531,498 in 5s. shares.

Business: The development and finance of gold mining properties on the Rand, particularly the deep levels and Far East Rand properties.

THE twenty-second ordinary general meeting of shareholders was held in Johannesburg on June 27, 1917, Mr. E. A. Wallers in the chair.

The Chairman, in moving the directors' report, balance sheet, and accounts, said that, having in mind the natural continuous increase in these times in the cost of production on the mines of these fields, shareholders would not have been surprised to find, when studying the report and accounts, that the ordinary income, which consisted mainly of dividends received from their extensive shareholdings, was £55,915 less than for 1915. The year's profit of £953,180 was, however, some £66,000 more than the previous year, due to a somewhat increased profit being derived from the sale of shares and added receipts on account of sundry revenue combined with a reduction in administration and other charges. Two dividends of together 150% were distributed, absorbing £797,248. 2s. 6d., and they invested during the year £142,245 net in property and shares. Finally they carried forward to this year the sum of £334,091, which was £13,802 greater than that brought forward the previous year. The cash position was, therefore, a little further strengthened, which was always a desirable feature. The dividend declared for the current half-year was also 75%. Exclusive of this last declaration, the total distribution to the shareholders of this corporation since its inception amounted to just under thirteen million pounds.

Before completing this brief consideration of the balance sheet, he wished to refer to a change of some importance that had occurred in the form in which it was presented. They were aware that the shareholdings as a whole stood in the books at a figure vastly below their value at actual market prices, and in individual cases, therefore, where the book figures were greater than the market value, they had not hitherto written those shares down, because of the very great surplus that existed as a whole. They had now altered that method, and every shareholding that stood in the books at a figure in excess of the market value had been written down to the market value. On the other hand, all those shareholdings that had always stood in the books very much below market value remained as they were. At the same time, they took the share premium account, together with the very large amount of money that had been appropriated from profits during a period of years for re-investment and merged them into a general reserve. This fund was approximately £3,000,000 at December 31 last, after providing for the depreciation to which he had referred, and also a depreciation of £100,000 that they thought it well to write off the book value of the reservoirs and pumping plant, which remained a most valuable asset. In contemplating the balance sheet they would bear in mind, therefore, that they had two reserves to their credit: this obvious one of approximately £3,000,000, and the other, almost equally obvious although not stated, that results from the fact of the shareholdings, etc., in their entirety standing in the books at a figure greatly below their market value. The financial strength indicated by the balance sheet was therefore striking.

Taken as a whole, the tonnage milled by the mines of the group of 9,125,905 tons and the total gold recovered, valued at £13,434,197, were practically the same as for 1915. Working costs, however, averaging 18s. 11·8d. per ton milled, were appreciably higher, and therefore the working profit at £4,772,893 was £350,000 less than the previous year. As regards working profit, the same feature in the year's work as he referred to at the last annual meeting was naturally in evidence in considering the operations for 1916. It was that the increase in cost of working attributable to the War, including increased taxation and increased cost of realization of gold, amounting to well over 3s. per ton in high-grade mines, was successfully counterbalanced by some mines having the necessary margin in their mine grade to call upon, whereas in other mines where such a margin did not exist the full effect of the increase was felt in the reduction of profit. Broadly speaking, the mines of the Far Eastern Rand in which they were interested, and to some extent also the City Deep, were able to mill ore yielding an increase equivalent to the rise in working costs attributable to the War; the mines of the Central and Western Rand in which they were interested were not able to do so.

The extra burdens which were being borne by the industry and which were attributable to the War—burdens which, of course, could not be handed on to the consumer, and which pressed particularly heavily on low-grade mines—constituted an annual charge of over £3,000,000, which was made up as follows:

Increased price of mine supplies, say	£1,750,000
Increased gold realization charges	400,000
War bonuses to employees	250,000
Allowances to employees on active service	300,000
War Levy	500,000

He would add that they could safely assume, as far as the mining companies which were attached to this company were concerned, that they bore half of that burden, that is, in the neighbourhood of one-and-a-half million pounds.

The ore reserves of the companies of the group were as follows at the end of their respective financial years:

Year Ended.	Company	Including Shaft and Safety Pillars. (Tons).	Estimated Value over Stoping Width. (Dwt).
31/12/16...	Modderfontein B.	3,371,950 ...	9·2
30/ 6/16...	New Modderfontein	8,013,370 ...	8·4
31/12/16...	Rose Deep	3,267,280 ...	5·3
31/12/16...	Geldenhuis Deep.........	1,616,000 ...	5·9
30/ 6/16...	Nourse Mines	2,169,300 ...	6·2
31/12/16...	City Deep..................	3,676,087 ...	9·0
31/12/16 ..	Village Deep ....:...	2,378,100 ...	6·8
31/12/16...	Village Main Reef.......	750,200 ...	6·6
30/ 9/16...	Ferreira Deep	1,632,600 ...	8·3
31/12/16...	Crown Mines	11,429,000 ...	5·9
31/12/16...	Bantjes Consolidated...	412,000 ...	5·6
31/12/16...	Durban Roodep't Deep	1,259,300 ...	6·3
	Total............	39,975,187	

Modderfontein B. had a very successful year. The tonnage milled 543,700 tons, working profit £687,289, and dividends paid (77½%) in each case represented a record. The ore reserves at 3,371,950 tons, averaging 9·2 dwt., showed increases of 581,210 tons and 0·45 dwt. in value. The plant was now being increased from 48,000 tons capacity to 60,000 tons per month and should be working on the higher scale about the end of this year.

Further progress was made by New Modderfontein to June 30, 1916. The tonnage crushed (635,000 tons) and working profit earned (£749.117) were records, while the ore reserves, 8,013,370 tons, value 8·4 dwt., showed an increase for the year of 2,002,570 tons and an all-round increase in value of 0·25 dwt. This was a highly satisfactory position. The new plant now being erected should be ready by the end of the year; it was impossible to be definite, but every effort was being made to overcome difficulties caused by the War. If the company was successful in this, the operations and consequent profit next year should be on a much larger scale. For the eleven months ended May 31 of this year the New Modderfontein had crushed 601,700 tons and had made a working profit of £718,042. They anticipated an increase in the revised ore reserves on June 30, 1917.

The Rose Deep had a normal year, crushing approximately the same tonnage, but working costs were 4d. per ton higher and the recovery per ton 1s. 1d. less, the resulting profit, £222,922, being £55,381 less than the year before. Dividends distributed were 26¼% compared with 32½% for the previous year. The ore reserves, 3,267,280 tons, at 5·3 dwt., showed a reduction in tonnage, but a slight increase in value.

The Geldenhuis Deep had on the whole a good year, crushing the highest tonnage since 1911 and making the highest profit since that date, namely, £169,478. Dividends paid were 25%, compared with 20% for the year before. The ore reserves showed a reduction of some 210,000 tons, the value being slightly lower than the previous year.

Nourse Mines' financial year ended on June 30, 1916, and while the tonnage crushed was a record the profits of £114,203 showed a reduction on the previous year of £43,840. Dividends paid were 10%. The West mill had been dismantled and operations confined to the Deep section. The profit for the eleven months to the end of May was £113,809, a slight improvement compared with the previous year. The mine had suffered, however, from a shortage of native labour, and despite an improvement in grade of nearly 4s. 10d. per ton milled, the working expenditure had been high, and owing to War conditions the full benefit of the change in policy had not yet been reaped. The development in the South Nourse section was fairly satisfactory.

City Deep had a record year, both as regards tonnage and profit, the working profit of £704,390 being £88,968 more than the previous year. Dividends amounting to 45% were paid, compared with 33¾% for the year before. The ore reserves showed an increase of nearly 700,000 tons, the value over the whole tonnage being 0·5 of a dwt. less, the decrease in value being due mainly to an increase in the estimated stoping width on which the reserves were recalculated.

Although crushing a record tonnage the profit secured by Village Deep was some £29,000 less than the previous year. Working costs were 2s. per ton more. Dividends distributed were 18¾%, compared with 21¼% for the year before. The ore reserves showed a comparatively small decrease in quantity but slightly improved value.

Village Main Reef was nearing the end of its life. The profit for last year was £161,638, compared with £170,175 for 1915. In the earlier part of the year profits were adversely affected by the accident to the shaft which took place towards the end of 1915. Two dividends were declared amounting to 25%.

At Ferreira Deep, the results to September 30 showed a profit of £458,695, practically the same as the year before. Dividends amounting to 38¾% were paid. This mine suffered from many underground difficulties caused by earth movements and pressure generally, and was at present adversely affected by the labour shortage. The ore reserves at the end of September were 1,632,600 tons, value 8·3 dwt., a reduction of some 221,500 tons compared with the previous year.

The Robinson company's profits, despite a considerable falling off in the revenue per ton and a slight increase in working costs, amounted to £367,151, a large scale of operations having been successfully maintained throughout the year. Dividends paid amounted to 8% compared with 14% the year before. This mine was dying hard. On previous estimates it should have ceased operations this year, but it was fairly certain that it would continue earning profits well on into next year. It was really impossible to state any definite time.

Having no margin in mine grade to call upon, Crown Mines felt the full effect of the heavy increase in working costs resulting from the War, and in addition suffered from an inadequate native labour force during the latter half of the year. Working profits were only £815,630, compared with £1,146,552 for the year before. Dividends paid were 50% compared with 65% for the previous year. Working costs were 2s. 2d. more and the working revenue showed an improvement of only 2d. There was thus a drop in the profit per ton from 9s. 2d. for 1915 to 7s. 2d. for 1916. Advantage was taken of the plentiful supply of native labour during the early part of last year to press on with development. The ore reserves showed an increase for the year of 1,491,000 tons, the value over the whole reserves having fallen, however, by 0·35 dwt., the decrease in value being due very largely to an increase in the stoping width over which the ore reserves were estimated. A start had been made with the No. 14 Shaft, the first step in the programme for the development of the company's ground south of the South Rand Dyke. This shaft was sunk 1,156 ft. during the year and at the end of last month had attained a total depth of 2,209 ft. A cross-cut was driven through the South Rand Dyke at the 16th level, No. 7 Shaft, showing its width to be about 450 ft. A bore-hole put in to prove the reef disclosed South Reef at a depth of 238 ft. below the 16th level, assaying 21·6 dwt. over 5½ inches. The Main Reef Leader at 404 ft. below the 16th level gave a value of 900·6 dwt. over 2½ inches. No great reliance could be placed on these figures, but they were at any rate an indication that payable ore might be expected south of the dyke. An encouraging feature was the increase in the percentage of payable development that had been met with. This year to date, owing to the better values obtained, development work was being directed chiefly to the Main Reef Leader. The company had now made arrangements to purchase from the Government the under-mining rights of certain water-rights, equal to 105·87 claims, within its boundary. The purchase consideration was an annuity of £9,926 for a period of fifteen years. The acquisition of these water-rights would considerably facilitate the company's operations.

Bantjes Consolidated had a very disappointing year. Although crushing a larger tonnage than the previous year, the working revenue fell to the extent of 1s. 10d. per ton, and in spite of a reduction in working costs a loss of £9,326 was made. The ore reserves, after careful revision, showed a decrease of 236,000 tons and half a pennyweight in value. The exploratory work in the Main Reef Leader, both in the eastern and western workings of the mine, had, however, given some encouragement, and although the losses during the first five months of the year had amounted to some £16,700, they had arranged the necessary financial assistance to permit further development on the Leader, together with further incline shaft sinking.

Durban Roodepoort Deep did not do well during the year, the profits amounting to £40,833, or £11,218 less than the previous year. The working revenue was lower, the working costs the same, and dividends 2½% compared with 7½% for the year before.

The supply of native labourers was, on the whole, satisfactory during the greater part of last year. During the latter part of the year, however, and the period since the beginning of this year, the supply had, unfortunately, steadily decreased. Thus, the number of natives in the employ of the gold mines of the Witwatersrand at the beginning of 1916 was 209,438; at the end of 1916 was reduced to 191,547, and during the current year had fallen still further, until at the end of May the number employed was only 180,168 labourers. Various causes had clearly contributed to this falling off. The diamond mines were employing about 18,000 more natives now than they were fifteen months ago, and the coal mines had also required and obtained more labour, the increase in the numbers employed by them over the same period being about 6,000. Activity in alluvial diamond fields, tin and copper mines and other industrial works had also accounted for a considerably increased use of native labour; these latter ventures were apparently employing about 15,000 more natives than they were at the beginning of 1916. And finally, they had to remember also that the recruiting of a contingent of native labourers for work in France—who had been of real service—accounted for an appreciable number of able-bodied natives. As regards their own group, they had in their employ at the beginning of 1916 65,000 native labourers; this number had fallen at the end of last year to 57,000, and at the end of last month to 55,000. The native labour position was therefore one that occasioned some anxiety, having in mind the continuous and progressive demand that existed. The working and health conditions of the native labourers had continued to receive the most careful attention of their officials concerned in that work. The mortality from disease amongst the native employees of their group for 1916 was the lowest on record, namely, 12·24 per 1,000, or 2·36 per 1,000 less than the rate for the previous year. They also further improved a little in the accident mortality amongst natives.

The activities of the Safety First Movement, under the Rand Mutual Assurance Company, Limited, and the stimulation of interest in First Aid Work, with the value help of the South African Red Cross Society and the medical officers on the mines, continued to be factors of the highest importance. This work concerned chiefly the white workmen, who, by becoming more and more imbued with the sense of personal responsibility, had together saved the lives of very many of their fellow workmen and the lives of many native labourers.

As regards the metallurgical efficiency of the mines of their group, the average extraction results—which had already reached a very high state—showed, as might be expected, very little difference. There was, as a matter of fact, a still further slight improvement. Much work of a very valuable character had been performed by the departmental heads in the matter of rigid ecomony in the use of cyanide and zinc and a resultant appreciable reduction in the consumption of these articles. General economy of a marked description had been in evidence in the work of the mechanical engineers as well as the metallurgists, both in the quantity of mining essentials consumed and in the way in which strenuous endeavours had been made, and successfully made, to use a variety of substitutes for the imported articles which it was impossible in some cases to obtain, as well as in the conserving and working up of all scrap material. The work had been thoroughly organized by their head office and mine office technical men and had been of great value to the group. Further appreciable economies were effected during last year in the use of lower-grade explosives in substitution for the higher-grade; or, in other words, they succeeded in doing the work with the consumption of far less glycerine than was previously used—a most important point, having in mind the more urgent requirements for glycerine in Europe.

He would refer briefly to some expansion that had taken place of their interests in the Far East Rand. Last year he drew attention to the acquisition of a half interest in a block of mining claims on the farm Vogelstruisbult in that district. Recently Government had advertised for tenders for the lease of four areas in the Far East Rand and one of these areas abutted on the Vogelstruisbult claims. Any success, therefore, that attended the exploitation of the area referred to would be of great interest to them. They had taken an interest with the Central Mining and Investment Corporation and the Transvaal Consolidated Land and Exploration Company in a prospecting venture on the farm Holfontein in the Far East Rand. Boring operations were now in progress, and, if encouraging information was obtained, further prospecting work would be undertaken. They had an interest in the Daggafontein Mines and they had also acquired a participation in the Brakpan Mines, in connection with the expansion of that company on the acquisition from Government recently of the Brakpan Lease. Then, since the close of last year they had also acquired an interest in the Modderfontein East, a company which was being formed to work the Government Lease ground lying to the east of the Modderfontein B. mine, together with the Cloverfield and Rand Klip mining areas. This company would have a mining area of about 2,350 claims. At the time of speaking, the unwatering of the Cloverfield shaft had practically been completed, and active development operations would shortly be undertaken. Therefore, their enterprises in this favoured section of the Rand were being well maintained, and if favourable opportunities offered in the future, might be still further increased.

Mr. E. J. Renaud seconded the resolution to adopt the report and accounts for 1916, and the motion was carried unanimously.

ROODEPOORT UNITED MAIN REEF GOLD MINING CO., LTD.

Directors: Sir George Albu *(Chairman and Managing Director)*, L. Albu, A. French, H. Newhouse, V. J. Ronketti. *Manager:* F. W. Girdler Brown. *Secretary:* J. V. Blinkhorn. *Office:* General Mining Buildings, Johannesburg. *London Office:* Winchester House, E.C.2. *Formed* 1887. *Capital* £460,000; loans £295,305.

Business: Operates a gold mine in the middle west Rand.

THE annual general meeting was held in Johannesburg on June 28, Sir George Albu, Bart., Chairman of the company, presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that for some years past the mine had shown only a narrow margin of revenue over expenditure, and although undoubtedly the developments in the main section of the property, the Kimberley Main Shaft, during the past year and a half had disclosed appreciably higher values than previously, only a very small percentage of this better grade ore had up to the present been available for milling. The accounts showed a recovery for 1916 of 19s. 11·1d. per ton milled, or an improvement of about 1s. 10½d. per ton on the recovery for the previous year. On the other hand, the working costs for 1916 of 17s. 9·9d. per ton reflected an increase over 1915 of approximately 7½d. per ton. The working profit for the past year as a whole was 2s. 1d. per ton, but during the last half of the year, when the adverse factors of shortage of labour and increased cost of mining supplies were being more severely felt, the working profit averaged only 1s. 7d. per ton. For the five completed months of the current year, during which the grade of the ore milled had improved, the effect of the decreased native labour supply and higher cost of stores was still more pronounced, the working costs having risen by an additional 10d. per ton to an average figure of 18s. 8d., equivalent to an increase of 1s. 9d. per ton as compared with pre-war conditions. Notwithstanding the difficulties described, the operations for the past year showed a welcome improvement on those obtained in recent years. The gross profit of £49,921 for 1916 was an increase of £28,808 over that for the previous year, and the net profit of £23,787 compared favourably with the net loss of £2,319 for the year 1915, and represented the best result obtained since 1911. In the Kimberley Main section the development work effected during the past financial year continued to disclose ore of a very satisfactory character, both as regards values and degree of payability. The figures showed that on South Reef 88·31% of the development was payable, giving an average value of 9·15 dwt. over an estimated stoping width of 42 in., and on Main Reef 36·45% of the development was payable, with an average value of 6·23 dwt. over 52 in. The disclosures for the lower levels of the section, between the 16th and 20th levels where development work had been largely concentrated, were still more encouraging, as the year's development gave a percentage of payability of Main and South Reefs together of 90%, with an average value of 9·8 dwt. over an average width of 44·6 in.

Mr. H. Newhouse seconded the resolution, and it was carried unanimously.

DOLCOATH MINE, LIMITED.

Directors: Frank Harvey *(Chairman)*, Oliver Wethered *(Vice-Chairman)*, J. M. Holman, H. C. Godfray, F. A. Robinson, F. W. Thomas. *Manager and Acting Secretary:* R. Arthur Thomas. *Office:* Camborne. *Formed* 1895. *Capital* £350,000.

Business: Works the Dolcoath tin mine, Camborne, Cornwall.

THE half-yearly meeting was held at the mine on August 31, Mr. Frank Harvey (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, said that the quantity of tin sold was almost exactly the same as for the previous six months. The amount received had increased by £13,036, due to a higher price of £26 2s. 6d. per ton. They had every reason to be satisfied with the speed of the work done by the diamond drill which had passed through 248 ft. at the 238 fm. level, north of Stray Park shaft, and 508 ft. at the 314 fm. level. The drill was now at work at the 510 fm. level, where it was hoped something good would be found. The large number of men serving in the forces made it impossible to carry out development work to the extent necessary. They could scarcely expect therefore to make a discovery, which they were so much in need of.

Mr. Oliver Wethered seconded the motion.

Mr. R. Arthur Thomas, the manager, said he had no very encouraging remarks to make or news of discoveries to announce. They had expected to make some discoveries in the 490 west of Wheal Harriet. It was a speculative point with chances of success attending it. They did not meet with any success, however. After they drove another 20 fathoms they would strike the cross-course in Stray Park and he anticipated that they would get a change of ground. There was every reasonable expectation that they would discover tin ground. That was practically the only development that had taken place. In the balance sheet they would observe an item of £213 for arsenic. He had no doubt that in the higher levels of Dolcoath considerable quantities of arsenic would be found to exist, but here they were confronted with the fact that they had no spare labour to do the work. Even if they had, the question of timber was a difficult one. They were doing what they could in the matter of producing arsenic, and during the next six months the amount for this production would be increased by a thousand pounds or so. In common with other places costs were greatly increasing. As an illustration he would give them the cost per ton for coal and electricity which were uncontrollable. For two and a half years before the war the average was 3s. 9d. per ton. For two years since the war it had risen to 5s. per ton, and during the six months under review it was 8s. 4d. per ton of ore treated. Budgetting for the next six months it was likely to be 10s. per ton.

The report and accounts were adopted unanimously.

The Mining Magazine

FOUNDED IN 1909 BY T. A. RICKARD AND EDGAR RICKARD.

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.SC., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill,* both Editions.

BRANCH OFFICES { 420, Market Street, San Francisco. 2,124, Equitable Building, New York.

SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XVII. LONDON, OCTOBER, 1917. No. 4.

CONTENTS.

EDITORIAL

SEVERAL mining engineers have recently been sent to France to supervise the work of the foreign war-labourers, such as Chinese and Basutos. This application of the experience of mining engineers in handling labour is particularly appropriate, and we urge the authorities to extend it.

RESTRICTION of the employment of quicksilver compounds for ordinary trade purposes becomes necessary owing to the large requirements for the manufacture of fulminate. Thus the new coats of paint on the motor buses of the London General Omnibus Company are not of the accustomed brilliant vermilion, but consist of the more sombre iron-oxide tints characteristic of the locomotives and coaches of the Midland Railway.

ELSEWHERE in this issue we publish a report by V. K. Ting, the head of the Chinese Geological Survey, on the mineral resources of China. Mr. Ting is the first native author to write on this subject, and his views are received with unusual welcome. He is not a believer in the theory of the wonderful and inexhaustible mineral deposits of China, and his statements may be taken as, in some measure, a corrective of the glowing accounts of the future prospects of his country as a mineral producer that have appeared of recent years in the technical and daily press.

THE production of stainless steel cutlery is one of Sheffield's great achievements of the last year or two. At the present time its manufacture is greatly restricted or entirely suspended owing to the war requirements in connection with chrome steel. The steel is the invention of Mr. Harry Brearley, and it contains 12 to 14% of chromium and 0·25 to 0·35% carbon. Unlike many types of stainless metal knives, it gives an excellent cutting edge. We can testify to the perfection of the metal, for we have had knives in constant use at the table for some months, and find that they withstand the ravages of even mustard pickles, the most corrosive of foods or condiments. They remain perfectly bright, and require nothing but a damp cloth for cleaning.

AN Academy of Engineers is a novelty. Such an institution has been inaugurated in America, and has already received its full charter of incorporation from the United States Government. Its membership will be confined to 200, and will include the flower, as it were, of all sections of the engineering profession, military, civil, mechanical, electrical, chemical, mining, and marine. The functions of its members will be largely those of guardians of the public welfare, and their services will always be officially and without cost at the command of the Government. Among the founders and first members are several well known in this country, Dr. R. W. Raymond, Henry M. Howe, Herbert C. Hoover, Hennen Jennings, and John Hays Hammond.

CAPTAIN Clem Webb, proprietor of the *South African Mining Journal*, is now in charge of a company of 500 South African natives serving as labourers in France. He speaks well of their efficiency as dock labourers and builders of roads and dug-outs. Their social and religious requirements are well looked after, by men having intimate knowledge of their language and customs. Those in Captain Webb's company are Basutos from the Northern Transvaal. There are also in France many Xosas from the Transkei, also Bechuanas, and Shangaans from Portuguese Territory. Not ten per cent of the natives have ever worked on a mine. Captain Webb won his Military Cross in the East African campaign. He has five sons at the war in various parts of the world.

CANDID and open understandings between nations provide conditions making for peace. President Wilson, the apostle of this wholesome doctrine, has done well to place the relationship between his country and Japan on this reasonable footing. Judging by the speeches of Japanese and American statesmen at meetings held in New York, the old antagonism between the two countries is being removed. For many years the Americans have suspected the Japanese of all sorts of world-empire schemes, and the resources of their picturesque slang of vilification have been strained to the uttermost in order to find words bad enough for their enterprising neighbours across the Pacific. It is now discovered that these ideas sprang from seeds of discord which had been sedulously sown by the enemy of mankind. The suspicion of Japan on the part of the United States was the one bar to the general agreement of reasonable nations. Its removal augurs well for the future of the human race.

FOLLOWING on the publication of the suggestions of the Bankers' Committee for the establishment of a decimal system of coinage in this country, the Chartered Institute of Secretaries canvassed its members for their views on the proposed change. The results of the canvass show a preponderating desire to adopt the decimalized sovereign, on the basis of the bankers' scheme as outlined in our issue of July last. A similar trend of opinion is evinced with regard to the metric system of weights and measures. Thus the society officially representing the keepers of our accounts and business records is getting ready to support the proposed changes.

LIKE a page from Bret Harte reads the story of the tragic death of W. H. Storms, one of the picturesque figures of Western American mining. Though it could be truly said of him that he was pre-eminently the prospector's friend, it was from a prospector that he met his death. Disappointed and revengeful that Storms could not see his way to help him to develop a property, the man turned aggressive and ended the argument in this deplorable fashion. Storms was a man of many parts. As a prospector and mine manager he was thoroughly at home in his labours. These occupations he varied with spells of editorial work, either on daily papers or with the *Mining and Scientific Press*. For a year or more he was State Mineralogist for California, but resigned as a protest against the habitual appointment of politicians to technical and scientific jobs. His book on "Mine Timbering" has worthily gained a place among our mining text-books. At the time of his death he was an assistant editor on the staff of Mr. T. A. Rickard, to whom he was a faithful friend and trustworthy colleague.

That One Per Cent of Oil.

It will be remembered that when the Butte & Superior company was defeated by Minerals Separation in the United States Supreme Court, which upheld the validity of the patent claiming a fraction of one per cent of oil, the company resorted to the plan of using more than one per cent with the object of evading the ruling. Along with many other people who know that among lawyers a legal quibble is the most solemn thing on earth, we imagined that the company was safe in taking this course. Fortunately, when the directors of Minerals Separation took the case to the court again, they found in Judge Bourquin a champion of common-sense and a man of the broad world, rather than a musty lawyer. We recorded last month that he had rendered a decision in favour of Minerals Separation. The full text of his judgment has now arrived in this country, and remarkably refreshing reading it provides. He chastises Butte & Superior with scorpions for resorting to the most transparent of dodges. He shows that, before the Supreme Court judgment, the company had demonstrated in practice the efficiency of the Minerals Separation process when $1\frac{1}{2}$ lb. of oil per ton was used, and that since the increase of the amount of oil to over 20 lb. the extraction had not improved, and had in fact slightly declined. The use of over one per cent was therefore both wasteful of oil and injurious to extraction. Thus, in his opinion, the Butte & Superior tactics were obviously only a device to evade the letter of the patent, and it was the duty of the law to "look quite through mere devices and forms to the substance of things." The use of the process with more oil than is necessary was held to be as much an infringement as if the most efficient amount was employed. Judge Bourquin is evidently a clear-headed, sound philosopher.

Since writing the foregoing we find that the judgment has fallen like a bombshell on the opponents of Minerals Separation in America, and the very arguments that appeal to us in the judge's favour are used against his possession of intelligence and sagacity.

Shortcomings in Tin Concentration.

In recent issues we and our contributors have had much to say on the subject of dredging for tin, and the relative efficiencies in recovery and concentration of the various types of dredges have been discussed. We intend to go more fully into the causes of the losses, and to present articles detailing both experience in practice and suggestions for improvements. In the present issue Mr. W. W. Richardson writes of losses in sluice-box and trommel practice, and he makes a suggestion for an alternative method of classifying and concentrating tin alluvium. Readers will regard the two sections of the paper from different standpoints. The first section gives the results of long experience, and the second proffers an untried idea, which tin-mining engineers will do well to ponder seriously. The author is a man of long experience in tin mining, having worked alluvial deposits in the Malay Peninsula, Nigeria, and Cornwall, and having managed the Huanuni mines in Bolivia for Senor Patino. In 1905-6 he was a member of the council of the Malay States Tailing Commission. His views and suggestions are therefore worthy of consideration. At the present time tin dressing is the most backward of all mining and metallurgical operations, whether it be at the alluvial or the lode mine. The committee of the Research Department of the Privy Council is using its best endeavours to investigate all ideas tending toward an improvement in practice in the concentration of lode-tin ores. It is possible that the members of the committee may see some possibility of applying the rotating concentrating surfaces to their own particular problems. It will be seen that Mr. Richardson specifically mentions the use of glass surfaces for catching the fine cassiterite. He made a close study of the action of this concentrating medium when it was prominently brought to the notice of the engineering profession two years ago by the experiments conducted by Mr. Morley Martin in Cornwall, and he is of opinion that this type of surface will give useful results whenever its right application has been ascertained. Frosted and fluted glass has been tested in America on Deister tables under the Schwarz patents. Mr. Morley Martin applied the glass to rotating frames. Mr. Richardson fixes the surfaces to the inside of horizontal rotating cylinders. Eighteen months ago we showed our desire to help forward the Morley Martin idea by giving it much publicity. We now allow Mr. Richardson his opportunity of introducing his proposals to the notice of engineers in a similar way.

Standard Screens.

The necessity for the efficient application of scientific principles to engineering problems has been continuously urged in this Magazine. We desire to assume the role of reformer whenever the reform is obviously to the advantage of the community, and is not inspired by political trickery or class prejudice. The establishment of a universally acceptable system of standard screens is one of the reforms required. Though the subject does not sound heroic in these strenuous days, it is undeniable that the reform would be highly acceptable in many trades, manufactures, and departments of engineering. We are aware that the Institution of Mining and Metallurgy established a standard series of screens a number of years ago. The apertures on which that series was based are sufficiently convenient for the average investigations with regard to ore-crushing, but the practical application of the screens is rendered well-nigh impossible, owing to the fact that the width of the hole is made equal to the diameter of the wire, and consequently the spaces are equal to only 25% of the total area. A glance at the medium and coarser screens brings to mind the Psalmist's remark about being "fearfully and wonderfully made." We are told that this ratio was adopted in order that there should be no difficulty in correlating holes per inch and their width. In fact the series was based on the idea of simplicity. No doubt simplicity is best, other things being equal, but where scientific efficiency is sacrificed just to please people who cannot be bothered to think, then an affection for simplicity is misplaced. To the philosophical mind, the discussions and proposals elicited at meetings of the American Institute of Mining Engineers and the Mining and Metallurgical Society of America, held two years ago, provided much more satisfactory food for thought. At the time, it was shown that a firm of screen makers, the W. S. Tyler Company, of Cleveland, Ohio, had already placed on the market a series of screens based on the Rittinger ratio of aperture, and constructed of wires of varying diameter most suitable for each individual screen. This was fortunate, for it removed the old bogey of " it can't be done," so often trotted out by manufacturers whenever improvements in practice are proposed. In our issue of November, 1915, we devoted considerable space to a consideration of the Tyler series, and we made specific suggestions for variations in some of the screens whereby the sizing would be further improved. Since that time the United States Bureau of Standards has taken up the subject, and discussed it with the aid and advice of representatives of many trades and professions. Mining men do not need to be reminded that they are not the only people to whom relative fineness of comminution is of interest. The requirements for screening range all the way from the producer of coarse road metal to the flour-miller and cement manufacturer who deal with impalpable powders. Our readers are requested therefore not to be alarmed at the wealth of detail contained in the many tabular statements issued under the auspices of the Bureau. There are more screens in the series than any one trade will require, but it does not take long for an ore-dresser to decide which of them will suit his own particular purpose. In our Mining Digest we reprint part of the table which gives the essence of the idea. It will be seen that the widths of successive openings bear the ratio of the square root of two, with, at the coarser end, intermediate screens having widths in the ratio of the fourth root of two. The standard aperture from which all the others are calculated is one millimetre. The standard ratio of the diameter of the wire to the width of the opening is provided by the screen having one mesh per centimetre ; here the wire is 2 millimetres in diameter and the opening is 8 millimetres wide. As the apertures become smaller, the ratio of wire to opening becomes greater, in conformity with the requirements of manufacture and strength, but in every case the effective area is kept as great as these circumstances permit. We ask our readers to give respectful heed to the suggestions of the Bureau of Standards. In spite of mental inertia on the part of engineers, reforms go forward. For instance, we seldom hear of the Cornish 37 mesh nowadays. Not long ago when a Cornish mill-man was questioned as to the fineness of the crushing in his stamps, he used to mutter something about " 37 "; on being pressed for an explanation of this mystic figure he would say that he believed the screen was punched with a 37 needle, but what the diameter of such a needle was or on what system the needles were graded, he was " blest if he knew." We have got farther than that now, and the march of progress will continue.

Our Iron Ore Resources.

It is well known that, owing to shipping difficulties of all sorts, attention has recently been turned by the Ministry of Munitions to the home resources of iron ore. For many years a notion has prevailed in this country that we have been rapidly becoming more dependent on imported ores for our iron and steel industries, owing to the exhaustion of our own deposits. Ever since the foundation of this Magazine in 1909 we have, on several occasions, attempted to correct this idea, and to demonstrate that immense reserves of iron ore still exist in the British Isles. The fact that ironmasters have imported ores representing one-half of the pig-iron produced does not indicate any shortness of supply of ore in this country. The explanation is afforded by the fact that richer and purer ores can be obtained, cheaply and without the inconveniences of vexatious land laws, from the north and south of Spain. Shortly after the commencement of the war we reviewed, in the issue of December, 1914, the position of the various belligerent countries with regard to their resources of iron and coal, but in that article we devoted chief attention to France, Belgium, and Germany. Now that the problem of ore supply in this country is more prominently in the eye of the public, it is appropriate to review our own resources.

We have, in other connections, frequently referred to the British Isles as a geological and mineralogical world in miniature. It contains within its limited area nearly every known characteristic rock and deposit. The iron-ore deposits are no exception to this rule as regards variety, though the extent of some of the ore-types, such for example as magnetite, may not be as great as in other countries. Undoubtedly the most valuable ores are the hematites of Cumberland and North Lancashire, which occur chiefly in the Carboniferous limestone, and also in Silurian limestone and slate. Then comes the ironstone, an impure siderite, found in the Coal Measures, and forming the basis of big industries in the Glasgow and Ayrshire districts, in Derbyshire and South Yorkshire, and in Stafford, Warwick, and Shropshire. At one time this ironstone was the controlling factor of the iron industry of South Wales, but it yielded to the competition of Spanish ores. The third great division of iron ores consists of the limonites and siderites of the Lias and Oolite, deposits of which stretch from Cleveland in North Yorkshire, through Lincoln, Northampton. and Leicester, to Oxford and Wiltshire. These are the deposits that lend themselves most readily to rapid development and mining at the present juncture. Their full development has hitherto been restricted by the presence of phosphorus, which makes the pig iron produced from them unsuited to the acid refining process. This drawback has been overcome in other countries, and the prejudice only lingers here. The exigencies of the war may finally remove it. The Cumberland hematite, as worked, may be taken to average 60% iron, though there are both higher and lower grades. Much of the lower grade ore that was thrown on the dumps after mining would repay concentration, and in this connection it is remarkable that until recently water concentration has not received serious attention. The ironstones of the Coal Measures are associated with varying amounts of clay, and the average iron content is about 33%. The constitution of the Lias and Oolite ore may be taken to be approximately the same. In addition to these three main groups, there are other occurrences of more or less importance. In South Wales, and in the Forest of Dean in Gloucestershire, there are hematite and limonite deposits, which promise a renewed importance. In Northumberland and Durham ores of similar characteristics and geological age are found. The siderites of Exmoor in North Devon and at the famous Perran lode in Cornwall, occurring in Devonian strata, have afforded many opportunities for the miner and metallurgist, but the results have been indifferent owing to the great variation in the constitution of the lodes and the presence of undesirable accessory minerals. We have already referred to magnetite. This is found sparingly in Yorkshire and also in Cornwall, but the deposits bear no similarity genetically to the magmatic segregations of Pre-Cambrian age. Finally mention should be made of the clay ironstone found in the Lower Cretaceous beds of the Weald in Sussex and Kent, and of the limonite found in the Miocene in Antrim, Ireland, in association with bauxite.

The history of iron smelting in England goes back to the earliest times. There is plenty of evidence that the Romans operated in the Forest of Dean and also in Durham and Northumberland, and it appears likely that they worked the Lias and Oolite in Oxford and Leicester. To the Londoner the old workings on the Weald provide a constant source of romance. No doubt these deposits were known to the Romans, but their chief interest lies in the fact that they provided much of the iron used in the Tudor and Stuart periods. The Cumberland ores were first developed in Norman times. The seventeenth century saw their important expansion, at a time when the copper and lead-mining industry of the Lake District was at its zenith. The purity of the ore and of the pig-iron produced from it gave Bessemer the chance to prove his process. The Staffordshire ironstone has been famous since the seventeenth century, and the district is notable owing to the first successful application of coke to iron-smelting in 1735, by Abraham Darby, at Coalbrookdale. The Scottish deposits assumed importance when Smeaton introduced new methods at Carron, a name which is still synonymous with high quality of product. It was not until 1850 that the Cleveland deposits in North Yorkshire were worked to any great extent. A few years afterward the deposits in the Midland counties, which had been entirely neglected since Roman times, began to assume importance. As we have already said, these Midland deposits promise to yield indefinite quantities of ore. Mining methods are of the simplest, and in many places they consist of nothing more than stripping the overburden, excavating the ore, and subsequently replacing the overburden. This can all be done by steam-shovel or drag-line machines. As regards Oolite deposits, it should be mentioned that the latest to be discovered is in the Dover district, where the existence of beds has been disclosed during the drilling and sinking for coal. As the control of these deposits has been secured by responsible ironmasters in the north of England, we may take it that they are of undoubted promise. It will be seen from the foregoing short statement that, with due diligence, the Ministry of Munitions will be able to provide very large amounts of the raw material required for steel manufacture from our home resources.

A Mining Engineer's Exploits.

Our friends often ask us to print articles recounting the experiences of mining engineers at the war. Unfortunately our opportunities for securing such contributions to our columns are rare. In the first place, the British soldier has so great a contempt for the braggart that he shrinks from publicly recording his exploits, and secondly he may hesitate to torture his memory by recapitulating a terrible adventure. Furthermore the press censor might have something to say as to the advisability of publishing certain information. Our articles bearing on war conditions have therefore been few. Mr. E. T. McCarthy wrote on Russian conditions, and we were able to give some details of the huts devised by Lieut.-Col. Peter Nissen. One day, perhaps, we shall be able to induce Major T. M. Lowry to tell us of the work of his Tunnelling Corps, or Major J. W. Teale to give his record of the departure from the Gallipoli peninsula.

One of the greatest of the exploits performed by a mining engineer was the destruction of the oil wells and stocks of oil in Roumania by Colonel Sir John Norton Griffiths. The details of this great adventure have just been published by the Roumanian Consolidated Oilfields, Limited, the largest of the English organizations interested in the Roumanian oil industry. This history of events was given to shareholders chiefly to show that the total destruction was ordered by the British authorities and carried out by a British officer, who pledged his word that full compensation would be granted by the Allies. That phase of the subject is, of course, of the most direct interest to those who had sunk vast sums on the enterprise ; but that is not all. The episode also shows how a man of commanding personality and inflexible determination can win his way single-handed against wide-spread opposition.

But before recounting the story it is advisable to say something of the importance of the Roumanian oil industry. In this connection reference may be made to an article on the subject, by Mr. R. C. N. Twite, published in the issue of the Magazine for December, 1911. Since that date the output has increased, the yield of crude petroleum having advanced from 1,350,000 tons in 1910 to 1,673,000 tons in 1915. The three biggest producing companies were the Astra, Americana, and Steana, controlled respectively by the Royal Dutch-Shell, Standard Oil, and the Deutsche Bank, each with a yearly yield of about 360,000 tons in 1915. The English company, the Roumanian Consolidated, is not so large a producer, the figure for 1915 being approximately 100,000 tons. The oil strata extend a considerable distance around the south and eastern sides of the Carpathians, but the region centring round Ploesti and north of Bucharest accounts for the bulk of the output. The Moreni field is the most prolific, and adjoining to the east are the Bustenari and the Campina oilfields. The Buzeu region is farther to the east, and the Bacau some distance to the north.

When Roumania declared war on the Central Powers in September, 1916, the oil industry of the country was placed in the hands of a State Commission, and production was controlled according to public requirements. By the middle of November the danger of the Roumanian armies was recognized, and it became obvious that the advance of the Germans could not be resisted. The Commission immediately devised plans to prevent the stocks of oil falling into the hands of the enemy and to prevent the wells from being operated. The proposals embodied the plugging of the wells with plugs having a secret pitch of screw and taper, the removal of a few parts of the machinery considered vital, and the withdrawal of the oil from the storage tanks and reservoirs to spots where it could be burnt without damage to tanks or buildings. The idea was to do the least permanent damage to the properties, and to trust that the invaders would be sufficiently inconvenienced thereby. This policy was pursued in a rather dilatory and inefficient manner for a few days. On November 25 the sudden appearance of Colonel Norton Griffiths at Ploesti caused much commotion in official and commerical circles. He announced that he had been sent by the British Government to help the Roumanians to destroy the oil wells and stocks of oil, and that he had so far received no assistance from the authorities or the owners of the properties. As the matter was desperately urgent, he took a strong course, and proceeded with a plan to destroy everything absolutely. Many and stormy were the interviews between him and the Roumanian Commission. Naturally he approached the English-owned company first for support, and, after giving his word that the Allies would fully compensate the company, he enlisted the services of the chief engineers, Messrs. Thomas Masterson and J. T. Hayward, for the purpose of carrying out his plans. His difficulties were intensified by the action of the members of the Commission, who not only opposed his suggestions, but on several occasions arrested his volunteer assistants while his back was turned. Even when they eventually consented to his policy, unwillingly enough, the progress of the necessary work was so slow that he had to lead the operations personally. Iron scrap was dropped down the wells to render them unworkable ; oil was let into the boilers and machinery and set on fire ; sulphuric acid was poured into the plant to corrode it ; and liberal use was made of sledge - hammers to break everything possible. As for the destruction of the stores of oil, some of the oil was allowed to escape from the tanks and was immediately set on fire. Within a minute the tanks, which then contained an explosive mixture of gas and air, began to explode with devastating violence. The wrecking party proceeded from one tank to another throughout the Moreni district, and destroyed over 40,000 tons of oil. The smoke from the conflagration formed a black cloud overhead which cut off the light of day, and the only illumination was that provided by the burning oil. The sparks from wooden structures set fire to the wells. The party finally turned to the works of the Astra company, and, after firing the tanks and the shops, attempted to destroy the power-house. It was found, however, that this building was full of gas, and members of the party advised its abandonment. But Colonel Norton Griffiths was not to be beaten, and he entered the building himself with lighted straw to set fire to the oil that had been pumped into it. The space was full of gas with little or no air, so our intrepid pioneer suffered, not from an explosion, but from the effect of burns. Several days were spent in destroying wells and plant east of Moreni, and subsequently the Buzeu and Bacau fields were treated in like fashion, and here again only just in time. Thus an English mining engineer, with the aid of the engineers of a British oil company, had saved the situation. We are, as a profession, proud of his exploits and of the indomitable will that overcame all obstacles.

REVIEW OF MINING

Introductory. — Londoners have had a taste of the war during the past month, provided by the visits of the air raiders on the moonlight evenings. The victorious progress of the British army in Belgium has acted as a useful tonic, as has also the brave speech of General Smuts. In mining matters, the registration of an Anglo-American company, bidding for areas in the Far East Rand, is a notable event. The rise in the price of silver continued during September, and 55d. per oz. was registered on the 25th. Subsequently the market was relieved by the appearance of supplies, and the quotation has gradually dropped, standing at 45⅛d. on the 10th. The United States Government has fixed the prices of copper and iron for a period of four months, and the British authorities have followed by reducing the quotations of standard copper to £110 and electrolytic to £125. The demand for steel in this country continues unabated, and additional works are still being erected. New issues of shares and other securities are rare nowadays, but we note with interest that the offer of debentures by Fraser & Chalmers was readily accepted by the market.

Transvaal. — The output of gold on the Rand during September was 712,881 oz. and in outside districts 25,350 oz., making a total of 738,231 oz., worth £3,135,807, as compared with £3,214,079 in August, and £3,277,408 in September of last year. The number of natives employed at the gold mines at the end of September was 171,334, as compared with 170,817 at the end of August, and 214,500 at the end of September last year.

The advent of American capital on the Rand is getting nearer. A company called the Anglo-American Corporation of South Africa has been registered at Pretoria, and it is making tenders for the areas in the Far East Rand now under offer. As the chairman and permanent director, Mr. Ernest Oppenheimer, is a director of Daggafontein Mines, and as Mr. W. L. Honnold, the other permanent director, was until recently consulting engineer to the Consolidated Mines Selection, we may take it that the latter company is not entirely without knowledge of the new venture.

A large number of bids have been received for the four new areas in the Far East Rand. The area, marked (*A*) in our map in the August issue, covering Springs farm and the southern portion of Geduld farm, appears to be the most sought for. Five tenders have been made to work it as a separate proposition, and three to amalgamate it with adjoining ground. Eastern Geduld (*B*) has received one bid on an amalgamation basis, presumably on account of the Geduld company. For the south-eastern portion of Rietfontein farm (*C*) three bids for separate operation and four amalgamation bids were received. For the south-west portion of Rietfontein (*D*) one bid on the separate plan and five amalgamation bids were received. It will take many weeks for the government authorities to examine and consider the various offers.

The directors of Springs Mines have already decided to increase the capacity of the plant. By local purchases it has been possible to make plans to treat 40,000 tons monthly instead of 30,000, and the new rate of output is expected to be effective by the end of 1917. Milling commenced in January of this year.

The Government last month asked for bids for the old Treasury mine. This property is a small one on the outcrop west of Geldenhuis, and it was worked to profit until 1910, when circumstances made it desirable to operate it conjointly with the neighbouring Jumpers. The mine was closed during the strike in 1913 and was not re-opened. The present proposition would hardly be attractive to a joint-stock company, but to a tributer a profitable result could be expected.

The East Rand Proprietary Mines records a working loss of £3,606 for September, the tonnage milled being 145,000 and the yield £137,449. The scarcity of labour is pressing the company hard, and the board is anxiously considering the position with regard to both current stoping and the scheme for development.

The labour shortage and the increased cost of supplies combine to make the position of many of the low-grade mines on the Rand precarious. Mr. E. A. Wallers, president of the Chamber of Mines, is conducting a strenuous campaign for an improvement in economic conditions with the object of preserving these mines from suspension of operations. He mentions that 15 out of the 50 producers are at present making no profits. If they were closed, the Empire would lose £7,000,000 of gold annually, and the working community £4,500,000 in wages. The increased cost of living has made it necessary to advance the rate of pay of white employees, but Mr. Wallers hopes that the men will not bring pressure to bear for unrestricted rises. The mines have combined for the pooling of machinery and other supplies, and the local production of steel is being fostered. In this way costs have been decreased slightly and the fear of scarcity of material partly allayed. As for the native labour situation, there are 27,000 fewer natives at work on the Rand now than a year ago.

Considerable interest is shown in the results obtained by Dr. Lister in inoculating natives against pneumonia. Recruits have been subjected to this treatment at the Crown Mines, De Beers, and Premier, with gratifying results, the mortality from this disease having greatly decreased. In fact it is believed that it has been extinguished altogether at the Premier. The treatment has also been successfully applied to the natives working as war-labourers in France.

Rhodesia.—The output of gold during August was worth £294,359, as compared with £288,731 in July and £338,001 in August a year ago. Other yields were: coal 47,214 tons, copper 341 tons, chrome ore 1,120 tons, asbestos 921 tons, wolfram 2 tons, diamonds 72 carats, silver 17,768 oz.

The exploration of the outlying portions of the Shamva property appears to be proving the existence of additional ore reserves. On the new section to the east of the main workings two shafts have been sunk and assay-values of 8 and 10 dwt. respectively have been obtained. The details in the cables are not quite clear, but as the development is to be pushed on this ore the conditions are presumably hopeful.

The first annual meeting of the Gold Fields Rhodesian Development Co. held since the capital was written down by half passed off well, and it was generally felt that Lord Harris had a more satisfactory statement to make than those to which shareholders had become accustomed of recent years. He referred to the developments at Shamva, and incidentally mentioned that the company had bought 34,000 Shamva shares during the past year at an average of 24s. 6d. Of the Falcon gold-copper mine he was able to express the hope that a first dividend would be forthcoming shortly. He spoke cheerfully also of the prospects at the Antelope. Of new mines, experiments were in hand for the treatment of the Planet and Asp ores. He laid stress on the development of chrome ore and asbestos deposits. In particular, the company has acquired 96,000 shares in the Rhodesian and General Asbestos Corporation. The company's income from dividends and other sources was £120,113, and £62,855 is being distributed as dividend, being 5% on the 2,514,220 shares of 10s. each. The chief sources of revenue were dividends on holdings in the Shamva, Eldorado, Gaika, and Lonely Reef. Unfortunately the end of Eldorado is in sight. Of mines that proved disappointments during the year are the Golden Kopje and Bell Reef, operations at which have been suspended.

West Africa.—The output of gold during August is reported at £130,278, as compared with £142,017 in July and £125,143 a year ago. Both Cinnamon Bippo and Prestea Block A show slight decreases. The Ashanti Goldfields announces the cutting of the Obuasi shoot on the 18th level, at 133 ft. from the main shaft. Here the lode is 19 ft. wide and averages 12 dwt. per ton. This assay is lower than that of the reserve, but development along the lode is necessary before its value can be exactly ascertained.

When the Kwall Tin Fields of Nigeria, Ltd., was originally floated the value of the properties was uncertain. Subsequent work on them has shown the prospects to be distinctly good. For the benefit of certain parties who contemplate taking a financial interest, Mr. John M. Iles was asked to make an examination. In his report, now published, he states that though the properties have been little tested the mining so far done indicates the presence of workable tin deposits. Two of the properties are on the Ouree and Ahoo rivers, on the plateau, and two, the Danshandon and Cameroon, are on the N'Gel river below the plateau. In the properties on the plateau the tin alluvium is covered with overburden. Mr. Iles is more impressed with the chances at the Danshandon and Cameroon, for the water-supply and other facilities are more favourable. He recommends that all the properties should be systematically bored and development undertaken.

The chairman of the Nigerian Tin Corporation, Mr. Oliver Wethered, was able to announce, at the meeting of shareholders last month, the return of the company to the dividend-paying list, an interim dividend for 1917 of 5% being declared. In the early days, from 1910 to 1913, this company did well out of the flotation of alluvial tin properties, but the war conditions brought an adverse period. With the present high price of tin, the value of its securities has appreciated. The corporation owns large interests in the Rayfield and Bauchi properties, and has smaller holdings in the Jantar, Gurum, Central Lafon, and others. It also has controlling holdings in companies operating or holding property in Cornwall, notably the Geevor, Porkellis, and Killifreth.

Australasia.—The coal strike in New South Wales has had serious results. For instance the Broken Hill Proprietary has to report the closing of the Iron Knob mine on August 20, and the stoppage of work at the coke ovens, blast-furnace, and steel furnaces. Operations are still suspended. The latest telegraphic news indicates that the coal miners are inclinded to accept the Government's terms, though there is still considerable want of unanimity.

The practice at Cock's Pioneer alluvial tin and gold mines was described in our July issue by the manager, Mr. A. H. P. Moline. The report for the half-year ended May 31, now to hand, shows that 365,000 cu. yd. of ground was treated for a yield of 3,783 oz. gold and 55 tons of tin concentrate. The net profit for the half-year was £9,450.

A mine that has had to suspend operations owing to the high charges of the Australian smelters is the Iodide silver-lead property, or Mineral Hill, as it was originally called. In our issue of January, 1913, we gave an account of this deposit, discovered the year before. Mr. E. F. Pittman, the State Geologist, at the time characterized the deposit as the most notable discovered in New South Wales since Broken Hill. For five years the Iodide (Mineral Hill) Co., Ltd., registered in Sydney, worked the property with indifferent success. The oxidized ore near the outcrop was rich in lead and silver. The grade, however, did not persist in depth. Sinking has not reached the sulphide zone, and presumably the conditions hold out no inducement to explore in depth. A struggle was made to work lower-grade ore, but the continual advance in smelters' charges gradually extinguished the profit. By Australian law, the ore cannot be sold abroad, so the company has been obliged to go into liquidation.

India.—Developments at the North Anantapur gold mine continue to be disappointing. The only new supply of ore discovered during the year was on the 300 ft. level south of No. 5 shaft, where the ore-shoot averaged 12 dwt. per ton over widths varying from 2 to 10 ft. for a distance of 90 ft. A parallel lode named the East Reef has been found by cross-cutting from the 950 ft. level north. This lode, where intersected, averaged 6 dwt. over 5 ft., but further development has not exposed any continuous lengths of payable ore, though sporadic high assays are obtained. The ore reserve on June 30 was estimated at 32,000 tons, a fall of 12,400 tons during the year. Further development in depth is being vigorously conducted. The ore sent to the mill averaged 9 dwt. during the year ended June 30, 1 dwt. higher than during the previous year, but still 4 dwt. lower than in the earlier years. During the year 26,500 tons of ore was milled and 31,200 tons of tailing cyanided, for a total production of gold worth £57,705. The working cost was £35,366, and £7,863 was written off for depreciation. Dividends totalling £7,531 have been distributed, being 4s. 6d. per share on 25,000 preference shares of £1 each and 6d. on 76,253 ordinary shares of similar denomination.

Canada.—The Ladysmith smelter, on Vancouver Island, is now in full blast again, after being idle for six years. This plant was built in 1901 by the Tyee Copper Company, and after the exhaustion of the company's mine was continued as a custom smelter for a time. The new owners formed a company called the Ladysmith Smelting Corporation, with Colonel Stevenson, a man well known in British Columbia and Alaska, at its head. The schedule of charges and payments shows an advantage over that of the Tacoma smelter in Washington, where most of the coast ores now go. In a recent issue we mentioned that Le Roi No. 2 had made a contract with this company owing to the temporary stoppage of the Trail smelter.

United States. — The Government has fixed the price of copper for the next four months at 23½ cents per pound f.o.b. New York. The output is still seriously curtailed by the strikes in Arizona, Utah, and Montana, but fortunately the troubles are confined to certain mines. The Inspiration, Miami, Old Dominion, Shannon, and Arizona Copper, all in Arizona, are the chief sufferers.

The United States Government has also assumed control of iron, steel, and coke. Iron ore is fixed on the basis of \$5·05 per ton, pig iron at \$33, and Connellsville coke at \$6·55. These prices are to remain in force until the end of the year.

The Bunker Hill & Sullivan is threatened with legal troubles over its old contract with the American Smelting & Refining Company. The mining company used to sell its silver-lead ore and concentrates to the smelting company, but recently erected its own smelter adjacent to the mine at Kellogg, Idaho. The smelting company now alleges that the change of policy constitutes a breach of a contract made in 1905. A hearing of the action is to be held this month at Portland, Oregon.

The figures for the output of iron ore in the United States during 1916 were published last month. The total production was 75,167,700 long tons, as compared with 55,526,500 tons in 1915. According to States, the largest amount came from Minnesota with 44,585,422 tons, of which 41,325,341 tons was from the Mesabi range. The adjoining States of Michigan and Wisconsin produced 18,071,016 tons and 1,304,518 tons respectively, so that the output of the Lake Superior district was 63,735,088 tons, or 85% of the total. The southern iron district, in Alabama, accounted for 6,747,901 tons, and the Adirondacks in New York for 1,348,507 tons. Amounts less than one million tons were produced in Pennsylvania, New Jersey, Tennessee, Virginia, Georgia, and Wyoming. The largest individual mines were the Hull-Rust in Minnesota, with 7,658,201 tons, and the Red Mountain in Alabama, with 2,899,588 tons.

Mexico. — It will be remembered that about a year ago President Carranza ordered mining companies to resume operations under penalty of forfeiture. The El Oro, belonging to the Exploration group, was the only company in that district not working at the time, and resumption was only made under protest. It is now announced that a dividend is to be paid, amounting to 5%, absorbing £57,375. The funds for this dividend are provided out of accumulated past profits. Owing to the high cost of labour current operations are not yielding any appreciable profits.

Bolivia.—The progress of the Porco Tin Mines Co., one of the Aramayo-Francke group, has been greatly hindered by war conditions. The output of tin concentrate during 1916, as recorded in the report for that year now issued, was 337 tons averaging 61% metallic tin, obtained from 25,721 tons of ore. The Krupp ball-mills have broken down on several occasions, and substitutes are being provided. The financing of operations has been difficult owing to Treasury restrictions, but loans have been advanced by some of the shareholders.

Russia.—While the British public has a haunting fear of the eventual result of the present Russian anarchy, little is being publicly said on the subject. A notable exception is provided by the speech of Mr. Herbert Allen to the shareholders of the Russian Petroleum Company, which operates at Baku. His statement was fearless and outspoken as to the dangers ahead. Outrageous demands of the workmen are already being not only endorsed but enforced by the Labour Commissioners recently appointed. At Baku the wages have been raised by this means to 4½ times the rate prevailing a year ago, with a prospect of further bonuses and of reductions in the hours of labour. As a slight offset the companies have been allowed to raise the selling price of the crude oil from 60 to 96 copecks per pood. The workmen also demand control of the office staff and practically of the business itself. In quoting Mr. Allen, we are aware that many engineers and directors associated with Russian undertakings deplore his utterances. They argue, with General Smuts, that we must not be too hard on a nation in the throes of re-birth, and that when peace arrives the Allies must help Russia to find itself.

The presentation of accounts by Russian companies is rendered increasingly difficult by the continual depreciation of the rouble. Thus the Orsk Goldfields, in its report for the year 1916 just issued, adopts an exchange of 15·5 roubles to the £ in the profit and loss account, the average exchange during the year; while in the balance sheet the rate is 16·2, being the quotation on December 31. The normal rate is 9·5 roubles to the pound. The sterling figures for the output as entered in the accounts may easily be misinterpreted by careless readers. From the point of view of the mining engineer it would have been better if the output had been quoted in fine ounces. The Kolchan dredge treated 730,515 yards for a yield worth (to the shareholders) £31,932, the Pokrovsky 133,537 yards for a yield worth £8,384, and tributers produced gold worth £13,247. These outputs correspond respectively to 12,260 oz., 3,219 oz., and 5,083 oz., worth in a gold-standard country £52,100, £13,680, and £21,613. The necessity for writing down the rouble has resulted in a loss for the year of £11,719. It will be remembered that in October last interim dividends were paid, 1·70 roubles on the £170,000 priority shares and 7½ kopecks on the £219,000 preference shares. Apparently none of the warrants had been cashed by the time the accounts were made up. At the meeting of shareholders held on the 10th inst. the chairman had a gloomy account to give of the results obtained during the year 1917. From the start this spring to August 13 the Kolchan and Pokrovsky dredges treated 404,000 cu. yd. for a yield of gold worth 176,000 roubles and tributers produced gold worth 56,500 roubles. Cables to the manager asking him to explain the serious fall in the yield per yard have not yet received a reply.

ELECTRIC WINDING FOR MINES

By W. R. EVANS, B.Sc. (Eng.)

In this second article the author discusses the methods of winding in which the alternating current is converted into a direct current, and he describes the Ward Leonard, Ilgner, and Westinghouse systems.

IT will be seen from the previous article that the control of the three-phase winding engine is in many respects similar to the control of a steam winder. The speed for any position of the control lever depends on the load as well as on the amount of resistance in the rotor circuit. Skilful operation is thus necessary to the same extent as in the case of a steam winder when providing for economic operation. The rheostatic control of the three-phase motor is sufficiently flexible for almost all cases of winding, but where sensitive or more definite control is necessary, the Ward Leonard system has special advantages.

WARD LEONARD SYSTEM.—In this system the winding motor is a direct-current shunt-wound machine which takes its supply from a motor-generator. It may be either geared or direct-coupled to the winding drum. The latter is the more useful practice, as there are no power-factor considerations with a slow-speed machine of this type. The driving motor of the converter set may be either alternating or direct current, depending on the supply, but the former only will be considered here, as power-supply is almost invariably three-phase. The armatures of the generator and winding motor are permanently in series, and the field circuits are separately excited from an exciter, either driven off the converter shaft or separately by a small motor.

With a constantly excited field the speed of the winding motor depends on the voltage across its terminals, the direction of rotation depending on the polarity of the applied voltage. Control is thus effected by varying the magnitude and direction of the excitation of the generator, which determines the magnitude and direction of the voltage applied to the winding motor. A rheostat dealing with the comparatively small excitation current of the generator is capable of controlling the winding motor throughout the whole cycle. The electrical input to the direct-current winding motor is proportional to the product of the torque and the speed, and therefore when constant torque is required during acceleration, the input to the converter motor is not constant at the maximum value, as in rheostatic control of a three-phase winder, but varies nearly proportionally to the speed of the winding motor. The curve of input is approximately a reproduction of the load cycle with the conversion losses taken into account. The heavy rheostatic losses inherent to the control of the three-phase motor are thus entirely avoided in the Ward Leonard system, as the only rheostatic loss in accelerating or retarding occurs in the field rheostat of the generator, and is almost negligible in comparison to the input. Although this points to far more economical operation than is the case with the three-phase winder it must be observed that additional losses are entailed by the use of a motor generator between the supply and the winding motor, and that the light running losses of the converter set are operative when the winding motor is at rest. The relative efficiencies of the Ward Leonard and induction motor schemes are so dependent on the form of the load cycle that it is even possible under certain conditions for the induction motor winder to come out more efficient than the Ward Leonard winder. The conditions are better for the former when the maximum speed portion represents a large portion of the time of one complete wind, and for the latter when the acceleration and braking periods represent an appreciable portion of the time of one complete wind.

CONTROL.—The outstanding feature of the Ward Leonard system is its method of control, and the readiness with which automatic devices may be adopted. The controlling rheostat of the generator is usually a potentiometer-type reversing resistance, arranged so that the brush arm may move in either direction from a central "off" position. The field excitation on the winding motor is maintained constant at its normal value during winding operations, but arrangements are made to reduce the current during periods of rest in order to save power consumption. With the control lever in the central "off" position, no current flows in the armature circuits of the two direct-current machines. Moving the controller in either direction excites the generator; the generator voltage, and hence the speed of the winding motor, depending on the extent of the movement of the controller lever. The speed of the winding motor is nearly proportional to the amount of movement of the controller lever, and is almost independent of the load. Direct control over the speed is thus obtained throughout the complete cycle. Retardation is effected by gradually moving the controller lever toward the "off" position, the speed of the winding motor having a definite value corresponding to each step of the control rheostat.

BRAKING.—Regenerative braking at practically any speed is an advantageous feature of the Ward Leonard method of control. During retardation, if the control lever is moved gradually back to the "off" position in advance of the natural retardation of the load, the counter electro-motive force of the motor exceeds the applied voltage of the generator. The motor therefore temporarily operates as a generator feeding back energy to the line through the converter set. The speed of the driving motor under these conditions should be just above synchronism. If a flywheel is coupled to the converter set for the purpose of load equalizing, this recovered energy is used in speeding the flywheel and set to normal, and thus relieves to some extent the load on the alternating current motor. The temporary generator action of the winding motor when retarded, as described above, provides an economical method of braking at almost any speed, returning energy to the line instead of absorbing power as is the case with the three-phase winder when braking on reverse current. The economical effect of regenerative braking is enhanced when the lowering of unbalanced loads has to be done frequently.

Owing to the comparatively negligible rheostatic losses when controlling speed, this system is almost equally economical when trips have to be made at reduced speed, such as winding men in main shafts. The smooth retardation necessary when stops have to be made at different levels in a vertical shaft is admirably accomplished with this type of winder.

AUTOMATIC CONTROL.—Since the speed of the winding motor bears a definite relation to the movement of the controller lever, automatic devices can be readily adapted to this system of control. The essential point is to provide for automatic regulation of acceleration and retardation entirely independent of the judgment of the operator, at the same time allowing sufficient margin for the driver to operate the control lever. The device should be operative if the driver has not already controlled within this prescribed margin. Such a device has the additional advantage that the cycle is worked to a more or less strict timetable, and in large mines having long periods of continuous winding this feature has an important influence on the output.

Fig. 4 shows a diagrammatic arrangement of an automatic device as used on Ward Leonard installations of Siemens manufacture. Two specially shaped cams, one for each cage, are driven from the spindle of the depth indicator by means of suitable gearing and arranged so that they make nearly one revolution during one complete wind. A system of links connects the cams with the controller and controller lever, in such a way that the motion of the cams restricts the maximum throw of the control lever at any point of the range. To commence the wind the lever is moved slowly in the required direction, the cams meanwhile allowing just sufficient play to enable the lever to be moved gradually until the full-speed position is reached. When retardation should commence the cams slowly force the lever backward, its movement then being taken up by the operator with a definite margin to play on. The cams limit the movement in this manner until the "off" position is reached. Over-winding is thus efficiently guarded against. The speed of the winder during the three periods of the trip is completely within the limits of control set by the motion of the cams. In

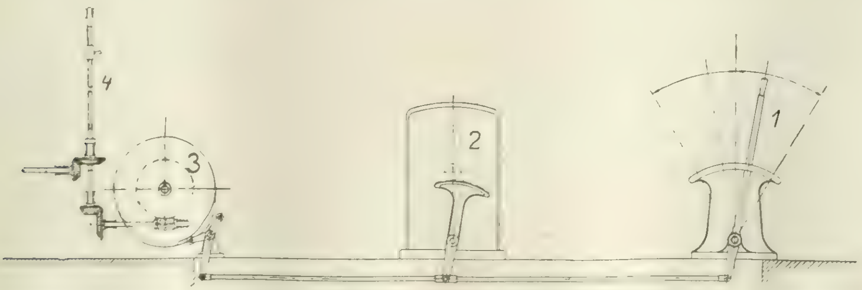


FIG. 4. DIAGRAM OF THE SIEMENS DEPTH-INDICATOR WITH SAFETY DEVICE.
1. Operating Lever. 2. Controller. 3. Controller Cam. 4. Depth Indicator.

whatever way the lever has been operated the cams have a definite control over the speed, which is automatically reduced to a low value when approaching banking level. A stop is attached to the cam shaft, which automatically releases the emergency brake in the event of a slight overwind. Further protection against overwind is sometimes provided by fixing a trip switch in the headgear which operates on the emergency brake if the above devices have not already operated. Another feature of this device is that an arrangement can be fitted by which the maximum displacement of the control lever can be fixed at a definite value. This attachment is desirable in the case where men or heavy loads are raised or lowered at reduced speed. It may be arranged to operate electrically from the bank level.

Automatic retardation when a load is being lowered is also controlled by the above device. The winding motor temporarily acts as a generator, and the speed is determined by the position of the control lever which is governed by the cam corresponding to the descending cage. Automatic devices of this kind are always in a workable condition, as they are in operation throughout the whole trip, and are therefore not liable to failure through irregularities due to infrequent use.

OVERLOAD PROTECTION.—The usual method of protection from overload in this type of winder is by placing an overload relay in the combined armature circuit of the two direct-current machines. This relay is so arranged that, when it operates through an overload, it opens the field circuit on the generator, and at the same time opens the brake-magnet circuit causing the application of the emergency brakes. This method has the advantage that the converter set is still running after an overload has been cleared, which would not be the case if overload protection was arranged only on the circuit breaker controlling the alternating current motor. It is good practice to install the circuit breaker which opens the generator field and brake-magnet circuits near the operator so that it may be operated by hand if desired.

Protection from failure of supply is precisely the same as in the case of the induction-motor winder, the no-volt release opening the brake-magnet circuit and applying the emergency brakes.

RELATIVE ADVANTAGES.—The relative merits of the three-phase alternating current winder and the Ward Leonard winder, and the suitability of either system for a given set of conditions depend on so many points that it is impossible here to do more than touch upon the main considerations.

On the question of control the advantage is decidedly with the Ward Leonard system. It has been mentioned before that the three-phase winder has almost the same operating characteristics as a steam winder. That is to say, if a strict routine has to be worked to with regard to acceleration, full speed, and retardation, the manipulation of the controller lever is different for different loads. A good deal therefore depends on the operative skill of the driver. The direct-current motor of the Ward Leonard system, on the other hand, has a more positive speed control which enables the same manipulation of the control lever for different loads. This feature allows the introduction of automatic devices, which not only reduce the human element in the control, but also provide an adequate safeguard against irregularities inherent to winders of any type. The finer and more definite adjustment of speed obtained with the Ward Leonard system is sometimes a necessary requirement when frequent stops have to be made at different levels. Winding at reduced speeds is accomplished much more efficiently with the Ward Leonard system.

It will be observed that the fluctuation of power demand on the supply is the same in the Ward Leonard system as in the three-phase system, as the load on the driving motor of the converter set follows the same contour as the load on the winding motor, but the maximum input during the accelerating portion of the cycle will be greater than that of the three-phase winder owing to the additional losses entailed by the use of the converter set. On a limited supply system this addition to the peak during acceleration may require some consideration.

Notwithstanding the heavy rheostatic losses necessary in the control of the three-phase winder, it is possible for this system to show less energy consumption per wind than the Ward Leonard system under certain conditions. The relative consumptions then depend on the characteristics of the load cycle, that is, the relations existing between the acceleration and rest periods to the whole time allotted to one wind. To meet a given condition, output per hour, it is possible to vary the form of load cycle to favour to some extent either system of winding. In continuous winding there is perhaps little difference in consumption in most cases working to normal cycles. When, however, the winding trip is frequently followed by lowering an unbalanced load, the Ward Leonard system has an advantage in economy,

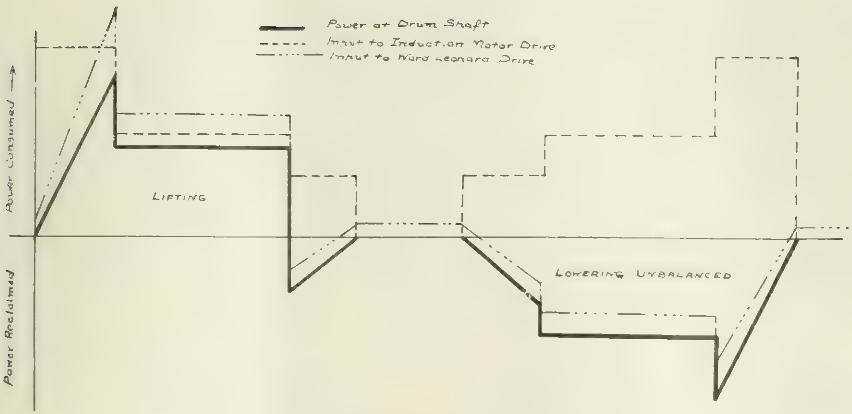


FIG. 5. COMPARISON OF POWER TAKEN BY WARD LEONARD AND INDUCTION MOTOR DRIVES.

in virtue of the fact that braking may be done regeneratively. This economy is more marked when comparison is made with reverse current braking of the induction motor drive. Fig. 5 gives a general idea of how the power taken and reclaimed varies with the two systems, assuming that braking with reverse current is employed in the induction motor case.

From the point of view of first cost the advantage is obviously with the three-phase drive, as the rating of each of the three main machines in the Ward Leonard system must be approximately the same as would be required for the alternating current drive. It may be possible in some installations to supply two distinct winders from the same converter set, the generator portion consisting of two machines in tandem driven by a single induction motor. The saving in aggregate rating, however, would only be appreciable in the case when the two load cycles overlap to a degree tending to equalization.

Since induction motor drives are mostly geared there is little to choose between the two systems with regard to power factor. But when the induction motor has to be direct-coupled to the drum shaft, the adoption of the Ward Leonard system with a moderately high converter speed may effect a saving in transformers and feeders by the higher power factor obtained.

It may appear that the occurrence of trouble is made more liable by the introduction of the intermediate machines necessary for the Ward Leonard control, but with modern plant there are few or no grounds for assumption in this direction. Owing to the comparatively low voltage at which the direct-current machines operate, insulation breakdowns are rare. The machines are usually provided with commutating poles and compensating windings, which go a long way toward eliminating sparking troubles on the commutator.

EQUALIZING.—The equalizing of the load taken from the mains by an electrically driven winder depends on the conditions under which power supply is available. The peak required during acceleration may be limited by the generating capacity behind the supply. Or again, it may be limited by the voltage drop in the feeders, in order that a reasonable regulation on the system may be adhered to. The influence of the drum profile is very marked indeed, and is an important factor in the choice of type of winder for proposed new installations.

The flywheel is almost universally employed for load balancing on winding plants, whether for alternating current or direct-current drive. There are a few installations in which the load is equalized by means of a buffer battery working in conjunction with an automatic booster. Present practice is, however, in favour of flywheel load equalizers, for plants dealing with large outputs at high speeds.

It is a well known fact that the stored energy in a rotating flywheel is proportional to the weight and the square of the speed. Thus, if the speed of a wheel is reduced by some means or other, the amount of energy given out will be a measure of the difference of the squares of the higher and lower speed limits. For example, if the speed is reduced 15% the energy given out will be about 27% of the original stored energy. From the above remarks it will be evident that to provide the most economical wheel the highest permissible speed should be arranged for. Marked improvements have been made in recent years in the construction of high-speed wheels, and steel plate wheels are now used which are safe at a maximum peripheral velocity of from 20,000 to 22,000 feet per minute.

The general arrangement of the Ilgner fly-

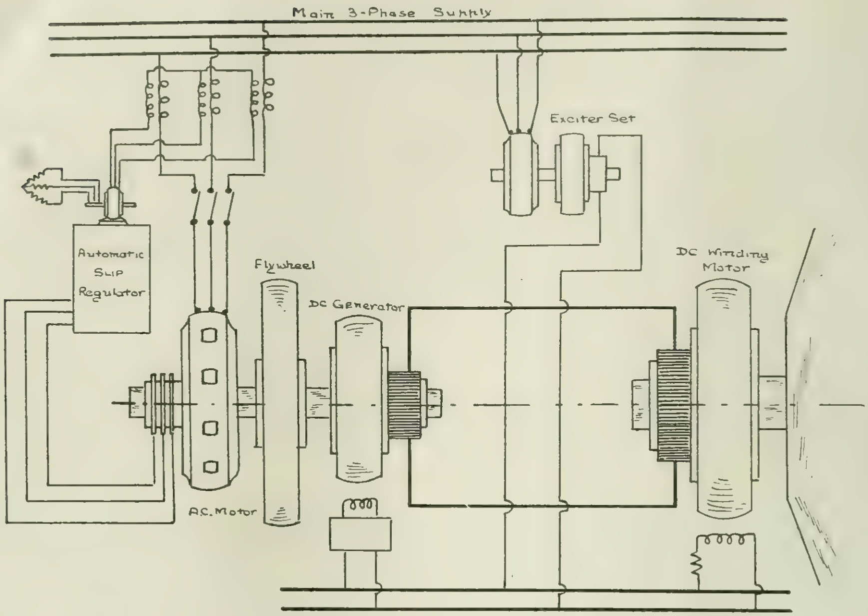


FIG. 6. GENERAL ARRANGEMENT OF ILGNER EQUALIZER SYSTEM.

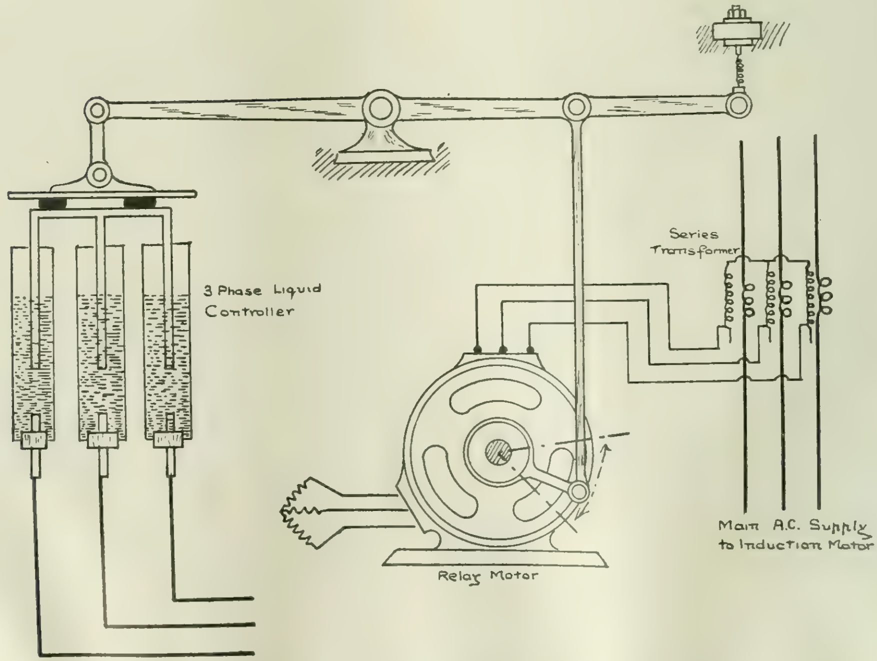


FIG. 7. GENERAL ARRANGEMENT OF AUTOMATIC SLIP-REGULATOR.

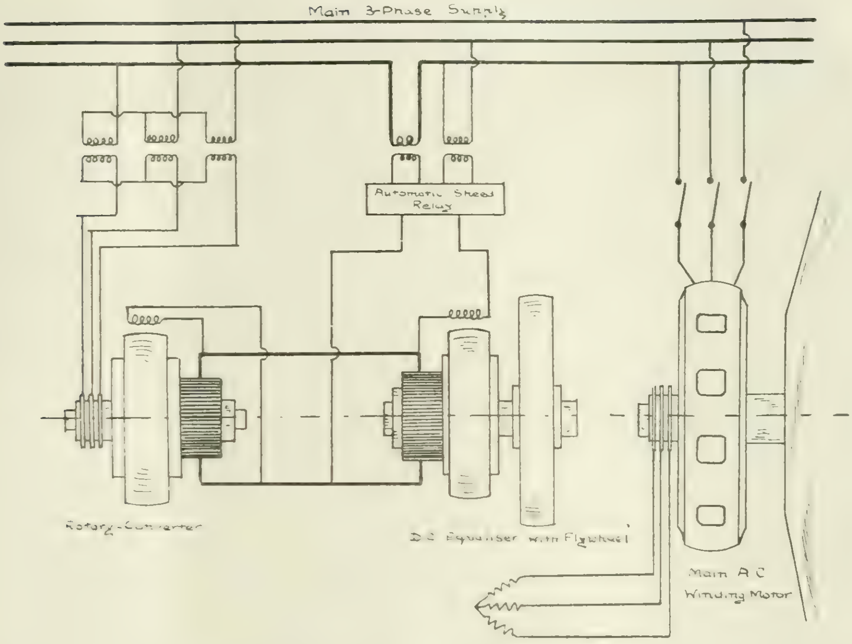


FIG. 8. GENERAL ARRANGEMENT OF ROTARY-CONVERTER EQUALIZER SYSTEM.

wheel equalizer is shown in Fig. 6. It consists of the usual complement of a Ward Leonard set with the addition of a flywheel on the converter shaft. A centrifugal device is operated from the shaft which breaks the supply in the event of the flywheel attaining a speed beyond the safe maximum. An automatic slip regulator is worked in conjunction with the alternating current driving motor. It is in circuit with the rotor windings of the inducton motor, and automatically introduces resistance in series with these windings when the load on the motor exceeds a limit for which the slip regulator is initially set. The regulator is shown diagrammatically in Fig. 7, and consists of a liquid-type controller in which the movement of the electrodes is controlled by a relay motor. The relay motor is operated from a series transformer in the main supply to the converter motor. When the current in the mains exceeds a predetermined value, the relay motor, which is counterbalanced, separates the electrodes, thereby decreasing the speed of the converter set, and enabling the flywheel to part with some of its energy.

Immediately before winding the conditions are as follows:—(1) Winding motor at rest with normal excitation; (2) Converter set running at normal speed slightly below the synchronous speed of the motor, that is, no external resistance in the rotor circuit; (3) Generator unexcited.

To commence the wind the generator is slowly excited as described with the Ward Leonard system. As the load increases on the winding motor the speed of the converter set decreases until the normal full load speed of the motor is attained, and the current input from the mains corresponds to full load current. Further increase in the load causes the relay motor to operate, producing a further drop in speed, and thus permitting the flywheel to assist in driving the generator. The decrease in speed continues until the limit is reached for which the system is designed, that is, in the case of complete equalization, sufficient to permit the flywheel to supply the necessary power over and above the average value required by the load cycle. During the remainder of the cycle the flywheel and converter set are speeded up to normal preparatory to the next trip. In a fully equalized system the load on the induction motor should remain practically constant during continuous winding, the only variations being slight fluctuations on each side of an average value due to the time-lag of the controlling apparatus.

Moderately high-speed wheels have an appreciable friction and windage loss, and this is partly responsible for the relatively higher consumption of the Ilgner set when compared with the Ward Leonard drive. It is common practice to arrange the flywheel at the end of the converter shaft with a clutch in between, in order that the flywheel may be disconnected from the set during the long rest periods which necessarily occur, or during the long periods of reduced speed winding which can be accomplished without equalizing. It was pointed out when discussing the operating characteristics of the three-phase winder, that when the speed of an induction motor is reduced by additional rotor resistance the electrical input remains constant with constant torque, the additional losses appearing in the controller resistance as heat. Precisely the same thing happens in the Ilgner system of balancing. The speed of the induction motor is reduced automatically, while the torque and therefore the input remains constant at approximately the full-load value. Energy proportional to the amount of half the total speed drop is lost in the liquid controller. This again accounts for a portion of the increase in relative consumption over the Ward Leonard system. But the main object is achieved, namely, in reducing the widely fluctuating cycle to a comparatively level demand throughout the whole cycle.

When two similar winding plants on the Ilgner system are installed for, say, adjacent shafts, Siemens Brothers adopt a method of coupling the flywheels in order to reduce the loss referred to above. Provided each wheel is heavy enough to equalize the load on its corresponding winder, and providing the phase difference of the winding cycles is such as to tend to equalization, this method of coupling the flywheels may reduce the slip-losses to almost one half of the value which would occur if the flywheels were allowed to operate separately.

In some cases peaks on the supply mains are not restricted to the extent for which complete equalization would be necessary. When this is so, a lighter flywheel than that required for complete equalization may be employed. The effect of introducing a lighter flywheel would be to increase the input to the set during the first portion of the cycle, and decrease the input during the latter portion, since less work is required to speed up the lighter flywheel to normal. This necessitates a driving motor with a higher rating, but since the rating may now be computed on the resulting input curve from heating considerations, the difference is not so great as it at first appears. It often results in a cheaper installation, as the reduction in cost due to some few tons decrease in flywheel weight may more than balance the increase due to the slightly higher rated motor.

Another method of equalizing is that known as the converter equalizer system, which has been developed by the Westinghouse Company. It retains the induction motor as the main winding motor. Fig. 8 shows the arrangement diagrammatically. In parallel with the alternating current motor on the main supply is a transformer which feeds a rotary converter, the transformer being necessary only when the supply voltage is above the limit for the satisfactory operation of the rotary. The direct-current end of the rotary is connected to a direct current machine which has a flywheel coupled to its shaft. This latter machine is shunt wound and operates either as a motor maintaining the speed of the flywheel, or as a generator deriving its power from the retardation of the flywheel. The field of the direct-current machine is controlled by an automatic regulator, operated from the main line current. When the load on the mains exceeds a predetermined value the regulator increases the exciting current, thus causing the speed of the machine to decrease and enabling the flywheel to drive it as a generator. The energy given out by the flywheel is usefully converted and pumped back into the supply, tending to maintain a constant load on the alternators supplying the system.

It will be seen that one essential difference between this system and the Ilgner lies in its relation with regard to the winding motor. In the Ilgner system the balancing device is in series with the winding motor and the mains. In the converter system the balancing device is in parallel with the winding motor, and is thus more independent of the winding gear. The rating of the machines comprising the balancer need only be sufficient to deal with the power required over and above the average for which it is intended to equalize. It may be designed to equalize for two or more winders working off the same supply. It is best suited to equalization for induction motor drives, as when it is desirable to retain the operating characteristics of the Ward Leonard drive, it would be obviously much cheaper to equalize by the Ilgner system.

The writer is indebted to the following firms for their kind assistance and for supplying illustrations of their present practice in electric winding engines: The British Westinghouse Electric & Mfg. Co. Ltd., of Manchester, Messrs. Siemens Bros. Dynamo Works Ltd., of London and Stafford, and Messrs. Allen West & Co. Ltd., of Brighton.

CONCENTRATION OF TIN GRAVELS

and a Proposed Alternative for Sluice-Boxes and Trommels.

By W. W. RICHARDSON.

AN article on Bucket-Dredging for Tin, by the present writer, appeared in the Magazine for March, 1914. It referred to the absence of improvements in the means taken to win the tin out of the gravel as it passed through the dredge, and it briefly described an improved design of the concentrating machinery intended for a dredge in contemplation at that date. Subsequent experience on particular dredges, solely in connection with investigation and close study of the difficulties of handling the gravel expeditiously and effectively, and at the same time keeping in view that the main object of the operation is to obtain as high an extraction of black tin as is possible, has more than suggested the pronounced unsuitability of a trommel and sluice-box as an effective apparatus for the classification and concentration of black tin on a dredge. Throughout the alluvial tinfields of Malaya there are thousands of Chinese fossickers making a good independent livelihood by winning tin out of tailing, and the point to be observed here is, that close to 100% of the tailing has previously passed through some form of sluice-box or ground-sluice. For this reason engineers in estimating the production of the forthcoming operations allow for the heavy loss of black tin which is inevitable where-ever sluice-boxes are in use.

The efficiency of a sluice-box decreases rapidly as the volume of flow and the quantity of gravel increase. Black tin does not easily come to rest out of a bulk of rapidly moving gravel, especially when the latter is overpowered by a large volume of water. The width of a box is important, so is the grade on which it is set, but the only available prevention of serious loss is in providing considerable length, and even then, the point of economy is soon overreached by the labour cost imposed and time absorbed in cleaning up.

It is not considered necessary to draw a comparison between sluice-boxes using riffles, which are supposed to automatically intercept the tin and leave the debris free to travel to the tailing, as against wide boxes in sections, provided with stops which are raised from time to time, as the spoil is concentrated by much use of manual labour. With both methods the loss is serious, not only in black tin, but in running time of the plant, and in money, due to the large labour force required to work the method.

The most effective sluice-boxes were to be found working on the alluvial gold mines in Northern California. Their length generally extended to several thousand feet, and often to two miles. These were cleaned up once or twice in a season. But in Malaya the contour of the ground and other local conditions restrict the length of sluices in the field, while the economical maximum dimensions of a dredge pontoon decides the width and length of the sluice-boxes which may be installed upon it. And as the heavy losses in values were immediately put down to want of length, so the period of cleaning up became a daily duty, and frequently twice in 24 hours. Still it may be safely said that the values continue to escape in the same proportion throughout the running hours.

The bulk of the tin in the Malay States is of a quality that lends itself to easy methods of recovery, but there is an important proportion of good fine tin which requires more refined treatment than is obtainable by the best sluice-box practice. Black tin, coarse or fine, will quickly find the bottom if it is given a chance to reach it, but it will not stay there; so means must be provided to seize it immediately it does come down, and at once carry it to safety. For this purpose it was proposed to use pulsating jigs let into the bottom of the boxes for the first thirty feet or more, and although considerable improvement was observed, the fine tin still escaped even when the minimum pulsations were adjusted to the jigs.

The reason for suggesting that the sluice-box and trommel are not suitable apparatus to be used in connection with a dredge extends beyond that of loss of tin, although this is of sufficient importance from the view of increased dividends that would follow a higher extraction of values out of the ground. Dredge running-time should mean money earned, and as the sluice-box will not effectively permit a continuous operation, the loss of time due to the periodical clean up may easily account for four to six weeks in a year. This statement is likely to call forth dissent, and it will be asserted that overhauling and repairs are pro-

Fig. 1.

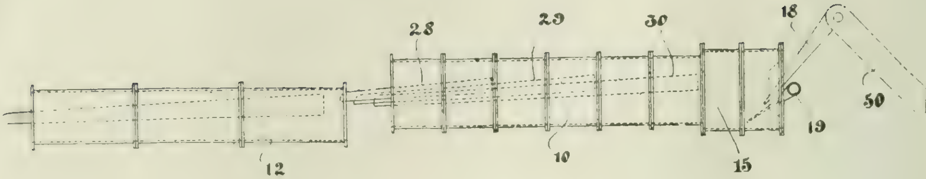
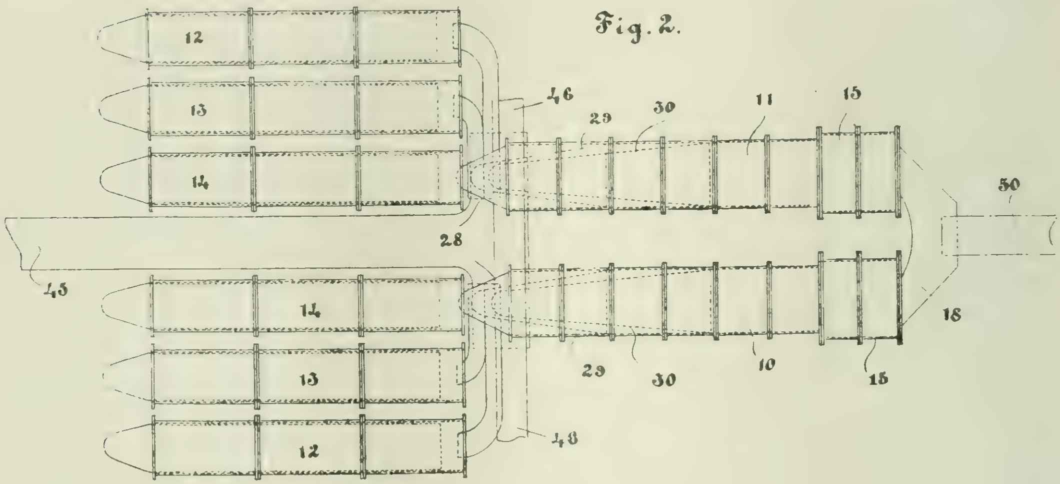


Fig. 2.



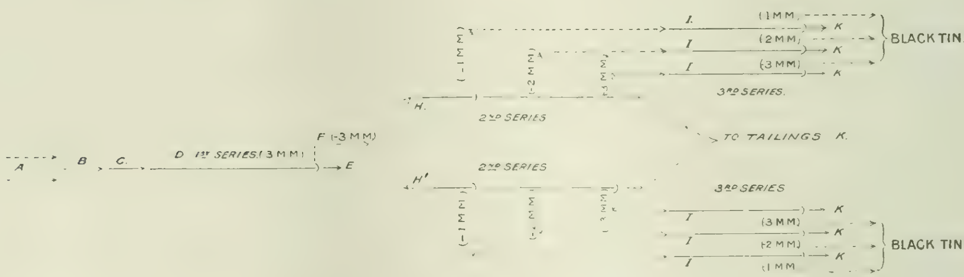


FIG. 3. PROPOSED FLOW-SHEET.

A. Bucket Chain; *B*. Gravel to Disintegrator; *C*. Disintegrator; *D*. Classifier (–3.m.m.); *E*. Discharged Tailing; *F*. Selected Gravel (–3.m.m.); *H*.H^1, Classifiers; *I*. Concentrators; *K*. Discharge to Tailing.

ceeded with while the cleaning up is being done. But assuming the dredge to be one of the best, and provided with proper engines, winches, reliable tumblers and bucket chain, there remains the water-supply pump, perforated water-supply pipe to choke, trommel screen to shake loose, or its smaller perforations to blind, or trouble with its bearings or transmission gear. Still, these are the inherent defects of separate parts of the whole apparatus now used for classification and concentration as at present applied on a dredge, and it seems more than doubtful whether this method can be further recommended as a type to be copied before a searching unbiassed investigation has been completed.

The periodical clean up is not the only cause of lost running time and reduced yardage. One nearly as serious is the overloading and choking of the sluice-boxes. This, besides interrupting the digging, is the cause of big losses in values which are carried away in the spoil as it is forced through the boxes. A similar loss of values may be occasioned by starving the boxes of spoil so far as to allow the water to scour the lower layers, which again starts the tin creeping out to the tailing.

Dredging is presumably a continuous operation, and a dredge as an excavator is quite efficient and automatic. Yet the part of its

Fig. 4.

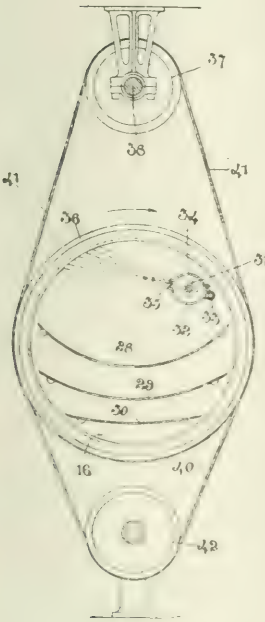


Fig. 5

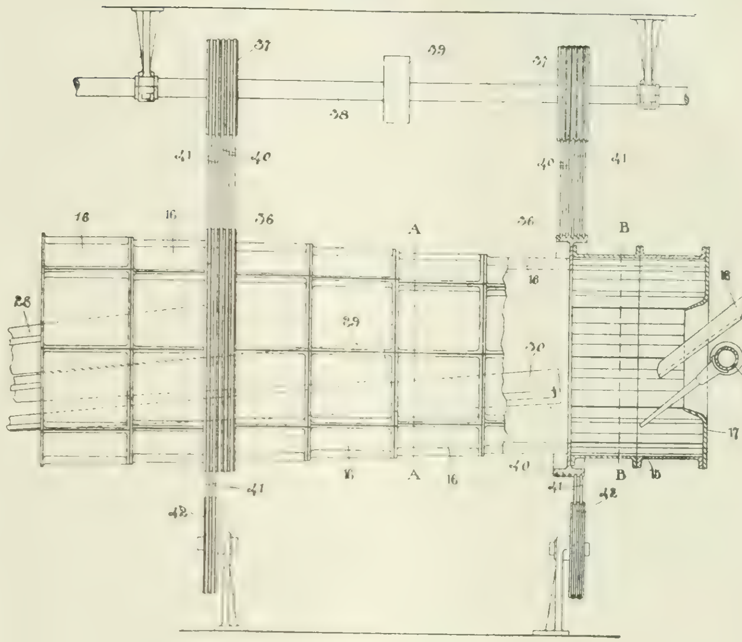
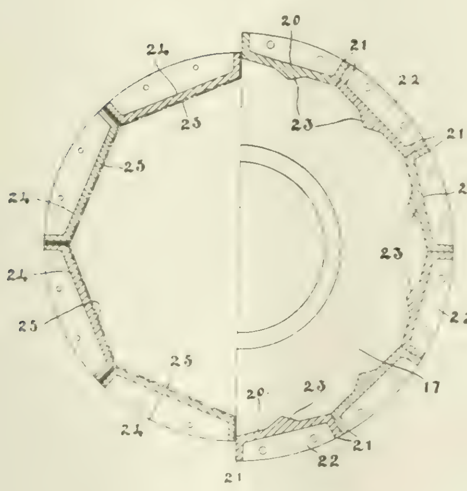


Fig. 6



machinery which makes the money is not automatic, is not effective, and even for the results which are obtained by this end of it, they greatly depend on the goodwill of labour, often unsupervised throughout 12 hours of night-work, paid at so much per hour. Space prevents presenting all the ills the dredge sluice-box is heir to, yet another of frequent occurrence is the need to trim the lie of the pontoon, otherwise choking or uneven working of the sluices occurs, and loss of values quickly follows neglect in this direction. Also from the point of view of cost, just think of the mass of material contained in their unwieldy design, and the expensive superstructure towering over 90 ft. above the deck in order to support them.

The stanniferous gravel which the dredge raises may be in size anything from minute particles up to pebbles, so long as the boulders may be ignored. The classification of this gravel is of the first importance, and the objective is to retain only that part of the material which contains the values, so that the debris may be rejected and discharged to the tailing with all possible despatch.

The general run of black tin may be anything in size from 0·001 to 3 millimetres, so it may be considered fairly safe to provide means of selecting all the gravel *minus* 5 millimetres in size. If this can be done it would often be possible to reject at once, as debris, quite 50% of the spoil delivered to the trommel. Yet experience decides that a perforated trommel acts indifferently when selecting sizes even as large as 10 millimetres, so the valuable advantage of the values resting in gravel of *minus* 5 millimetres is nearly entirely lost. Classification is essential to concentration even in a sluice-box, and the idea that pebbles hold up tin may be right so long as the pebbles remain stationary, but a flow of water equal to moving a pebble 10 millimetres in size is certainly going to move a grain of tin of 5 millimetres in size. So it would appear that a trommel which is ineffective in selecting material 100% larger than is required will assuredly prove useless in economical dredging practice.

The trommel is a step in the operation between the buckets and the sluice-boxes. It is intended to divide the material in which lie the values and pass it into the sluices for concentration. It is seen that it performs this duty most indifferently. Yet it will not even go as far as this unless assisted by an inconvenient volume of water which is generally more than is required for the best work the boxes are capable of giving. Should the quantity be reduced then disintegration of the spoil is interfered with, and losses again occur through the values being carried out directly to the tailing.

It is these negative features in the present form of trommel and sluice-box that prevent a larger profit being made on the properties operating in Malaya. Were these disabilities eliminated, the large areas of worked ground and low-grade ground could be worked at a profit. But the trouble is inherent in the method, as well as in the apparatus; so much so, that even with elaborate additions to the present machinery, only a fractional advance toward a maximum possible efficiency could be made. The stanniferous areas in the world that are assumed to be of commerical value are small in proportion to the increasing demand for tin, so the economical treatment of ore reserves under active operation will, as time advances, become a matter of the first importance.

The mineral dredge as a plant of mining machinery lends itself to treatment in design which may well render it completely self contained in every detail. It has the advantage of carrying its home with all its chattels on its back right up to the work it has to perform, and of moving obstacles including its own debris completely out of its way. It can supply sufficient motive power for all likely requirements, and provide a reasonable amount of space for effective concentrating machinery. Given a general arrangement that would provide an automatic operation, there is nothing in the way of mining alluvial tin, without the least handling being necessary, by manual labour, right from the gravel *in situ* and out to the tailing ground.

It is possible to obviate the disadvantages of both sluice-boxes and trommels by means of a design which is here illustrated. Briefly described, the plant consists of revolving horizontal cylinders lined with concentrating surfaces. The machine is a classifier as well as a concentrator. Its performance with material of sizes between 3 and 5 millimetres is quite good, but practical accuracy is obtained in all smaller sizes, and markedly so when below one-hundredth of a millimetre. The concentrator is built in sections of increasing diameters. It is suspended in and slowly revolved by endless steel wire ropes. The machine is easily erected and taken down in the course of a few hours. It can be installed in any position on the roughest field, and as a classifier and concentrator it may be worked in conjunction with any system of mining.

The method is designed to effectively deal with all the ground broken down by hydraulic jets, or raised by gravel-pump or bucket-dredge, of any dimension, so that the excavating plant shall not be restricted in capacity, while at the same time extracting a high percentage of the values. No overloading or choking is possible, and as its action provides a continuous application of clean selecting surfaces which come in contact with the lowest layers of the spoil, and as it moves through the spoil at right angles to its flow, all the values are seized as they come down and are immediately carried to safety where they are discharged on to trays. The operation is so far automatic as to require no other labour than three men per shift, as attendants on the machinery.

The illustrations Fig. 1 and Fig. 2 show the arrangement of the series of cylinders, 10 and 11, and 12, 13, and 14, containing the internal trays which catch the concentrates continuously falling from the revolving surfaces. Fig. 3 diagrammatically represents the flow of the material treated. Figs. 4, 5, and 6 give details of the construction of the cylinders and their internal concentrating surfaces. The gravel is fed to the cylinder through the chute 18 and is broken up in the first compartment, shown in section in the right side of Fig. 6, by means of a jet issuing from 19. The subsequent sections of the cylinder are of gradually increasing diameter. The concentrating surfaces, as shown in section in the left side of Fig. 6, are made of manganese steel in the first series, and of frosted or fluted glass in the following series. The illustrations show the design so fully that further description is not necessary. The writer would welcome discussion on this new proposal for treating tin gravel.

LATERITE:
ITS ORIGIN, STRUCTURE, AND MINERALS.

By J. MORROW CAMPBELL, B.Sc., M.Inst.M.M., F.R.G.S.

(Continued from September issue, page 128).

The third instalment of this article relates to Secondary Change in Laterite, the Iron - Alumina Ratio in Laterite, and the Origin and Structure of Bare Laterite Sheets.

Chapter VI.—Secondary Change in Laterite.

The first result of laterization is the production of a mixture composed mostly of ferric and aluminium hydrates in the amorphous condition, mixed with hydrous silicate of alumina and such insoluble material as was contained in the rock when the process commenced. This assertion is made as the result of observation of laterization in its earlier stages, and is supported by evidence obtained in the examination of older laterites. In these the microscope reveals which parts have been subjected to least change. These are usually composed mostly of amorphous constituents. Sometimes crystals are abundant, but they are distributed in such a way that they are evidently the result of segregation in an amorphous matrix and not of deposition from aqueous solution.

Generally speaking laterites which show by the complexity of their structure the most abundant evidence of secondary action are highly aluminous.

Secondary changes in laterite resulting in the elimination of iron usually tend definitely toward one of two apparently stable final conditions: the production of crystalline aluminium tri-hydrate (gibbsite), or the production of amorphous hydrates of alumina. The trihydrate appears to form first; this is converted into the di-hydrate $Al_2O(OH)_4$ in part or wholly. In some old pisolitic laterites even the amorphous monohydrate $Al_2O_2(OH)_2$ is found. The conditions determining whether crystalline or amorphous aluminium hydrate is formed are not known. The oldest laterites in West Africa have almost all their alumina in the crystalline form as gibbsite $Al_2(OH)_6$, and this compound displays no tendency whatever toward degradation to simpler amorphous forms. In no case in West Africa has the writer found an old laterite high in alumina in in which gibbsite does not occur. Secondary action invariably results in gibbsite forming in greater or less quantity, either by segregation from amorphous mixtures or by deposition from solution in passages and cracks.

The segregation of gibbsite crystals has not been observed to have taken place in a matrix of pure amorphous hydrate without ferric hydrate. From a mixture, however, segregation of gibbsite crystals is very common, but in their immediate vicinity there is almost always to be found also segregated ferric hydrate or oxide. This does not contain more water than turgite and may even be anhydrous. It segregates in two forms: one in a fine state of division, amorphous, opaque, and red by reflected light; the other in black opaque grains with metallic lustre and red streak. Even secondary hydrates introduced into passages in bauxitic laterites after the almost complete removal of the original iron content undergo segregation into gibbsite and red ferric hydrate or oxide.

The fact that gibbsite segregates much more readily from mixed amorphous hydrates than from amorphous aluminium hydrate alone, and the fact that segregation of gibbsite and the iron mineral appears usually to take place simultaneously, lead one to suspect that the segregation of one is dependent upon that of the other. As has been noticed by Prof. Lacroix, the amorphous mixture does not contain nearly enough water to permit the full hydration of alumina and of iron to limonite. To explain these phenomena most readily we ought to have the two hydrates in combination, and it seems not improbable that a hydrated ferric aluminate may exist which under favourable conditions breaks up, yielding ferric oxide and gibbsite.

There can be no doubt that the tendency during secondary change in most ferruginous laterites is toward complete hydration of alumina and complete dehydration of ferric oxide.

Similar mixtures of amorphous hydrates, transparent and varying in colour from yellow to blood-red by transmitted light, are deposited in stalactitic form and in layers lining cavities and passages. These sometimes become opaque, and if the iron is removed by weak acid one finds that the aluminium hydrate is being transformed into crystalline form, a dark cross resulting from aggregate polarization being plainly seen in a section rotated between crossed nicols.

Highly aluminous laterites, which are so often almost wholly amorphous, usually consist of a mixture of the tri and di-hydrate. In the absence of iron there appears to be little if any tendency toward the formation of gibbsite. On the contrary, the tendency is distinctly toward de-hydration of the amorphous tri-hydrate which certainly breaks up, yielding earthy di-hydrate and even monohydrate.

Photography in monochrome is incapable of giving results illustrating quite satisfactorily the structure of laterite. Fig. 7 for example gives only a vague idea of its complexity. The same applies to Figs. 5, 6, 15, & 17.

Nothing could possibly be more misleading than the idea that a highly evolved laterite comes into existence by the rearrangement, alteration, weathering, or metasomatic replacement of the constituent minerals of a crystalline rock. Laterite does not form *per saltum* from any rock. Highly evolved examples are the result of a prolonged succession of changes, deposition, solution, re-deposition, hydration, de-hydration, and segregation, repeated many times, so that the ultimate composition may bear no relation whatever to that of the unaltered rock which originally occupied the same actual space, but was determined entirely by external agencies. The pisolitic laterites give us the clue to what really takes place in laterites in general and causes complex structure. Under certain unknown conditions laterization from its earliest stages takes a concretionary form. Spherical masses of mixed colloidal ferric and aluminium hydrates form at approximately equal distances apart in a porous argillaceous medium; they grow outward by additions of the same hydrates in varying ratio until they meet one another; then the inter-spaces only partly fill, passages always remaining open. The pisolites usually vary between 3 and 10 m.m. in diameter. Fig. 8 shows a polished surface of such a laterite that has not undergone much secondary change. Compare this with Fig. 10 in which only fragments of pisolites remain. Fig. 9 shows an intermediate stage and illustrates how change is produced. Where half a pisolite is found *in situ* we know the missing half can have been removed only in solution.

Much speculation has taken place as to the origin of passages in laterite. Some writers seem to imagine that passages once formed persist throughout the life of the rock. This certainly is not so. By studying pisolitic laterite we gain information of a definite nature owing to the symmetrical structure of the concretions such as we cannot obtain from any other type. The primary passages always pass between individual pisolites, and the cement material undergoes more rapid, frequent, and greater change than the concretions. This can be seen in the commonly lighter colour and consequently less ferruginous nature of the cement. The original cement usually resembles the pisolites fairly closely in composition.

Figs. 8 to 11 show this. Where original cement remains it can be quite readily recognized by its darker colour. The pisolites themselves are seen in places to be leached of iron, some are partly removed, and it is evident that many have entirely disappeared. Even segregated ferric oxide is dissolved.

These illustrations prove beyond question that solutions traversing the laterizing zone are capable of dissolving lateritic material, form passages through the hard rock, and anon fill them again with other lateritic material which is generally more aluminous than that removed. This operation does not take place once only, but is repeated again and again apparently throughout the whole period during which the rock remains in the laterizing zone. Each passage formed follows an uncertain course through pisolites and cement old and new until such a medley as is seen in Fig. 10 results. When such a mass is broken fracture will take place as readily through concretions as through newer materials; all is of about the same hardness (except segregated iron oxide) and all takes a high polish.

As to the origin of pisolitic laterite the aqueous theory must be abandoned. Pisolites undoubtedly form by concretionary action *in situ* in permeable solids through the agency of passing solutions. A homogeneous medium apparently favours their formation, but it is not essential. Indian ferruginous pisolites often enclose grains of quartz over 1 m.m. in diameter, but not as nuclei. Sand particles have also been found in African and South American pisolites; in these no nucleus of foreign matter was ever found though large numbers were examined. Fig. 11 shows pisolites developed in an Ashanti laterite which was formed from a sedimentary clay containing abundant old laterite fragments. It has undergone considerable secondary change. The pisolites seen are formed *in situ* and did not accompany the water-borne fragments.

The internal structure of pisolites is seen in several of the figures. The concretionary layers vary in colour and composition but appear originally to be entirely amorphous. The secondary changes are interesting. Fig. 12, which

(*continued on page 177*).

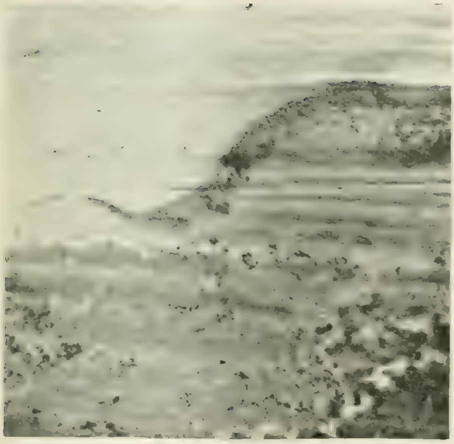


Fig. 1

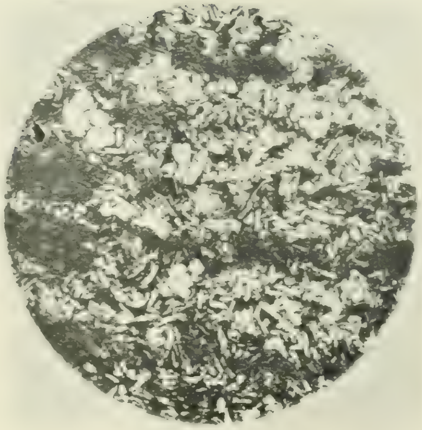


Fig. 2.

Fig. 3.

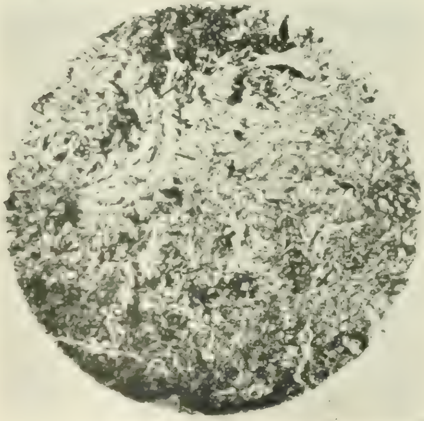


Fig. 4.

DESCRIPTION OF PHOTO-MICROGRAPHS ON PAGES 173 TO 176.

FIG. 1. Photograph of smooth surface of semi-laterized dolerite from Monguna, Northern Nigeria. Consistency, clay-like. Appearance pseudo-sedimentary, caused by deposition of minute spherules of crystalline ferric hydrate from vadose water in parallel layers of varying abundance. The mottled appearance arises through re-solution of the ferric hydrate (or its segregation), leaving patches of almost pure amorphous aluminium hydrate. Reflected light. Magnified 2 diameters.

FIG. 2. Section of No. 1 showing outlines of crystals of the mother rock. The parallel bands of ferric hydrate are plainly seen. The outlines of the felspar laths are distorted, proving sericitization to have taken place as an intermediate stage in their alteration to hydrous silicate of alumina. Photo-micrograph by ordinary transmitted light. Magnified 15 diameters.

FIG. 3. Section of No. 1 showing spherules of ferric hydrate, some single, others in groups. Photo-micrograph by ordinary transmitted light. Magnified 90 diameters.

FIG. 4. Section of gibbsitic laterite, Monguna, Northern Nigeria, derived from dolerite. Outlines of crystals of the mother rock plainly visible. Photo-micrograph by ordinary transmitted light. Magnified 15 diameters.

FIG. 5. Section of laterite from Ashanti, derived from granite. The four large white patches are open passages. The black portions are ferric hydrate. The white bands are gibbsite crystals formed round old passages. The white irregular markings and specks are also gibbsite, much of which has segregated from a mixture of the amorphous hydrates of iron and alumina. Photo-micrograph by ordinary transmitted light. Magnified 12 diameters

FIG. 6. Photograph of polished surface of semi-pisolitic laterite from Ashanti, derived from schist. It consists almost entirely of amorphous material and has undergone very extensive secondary change by dissolution and re-deposition. Magnified 4 diameters.

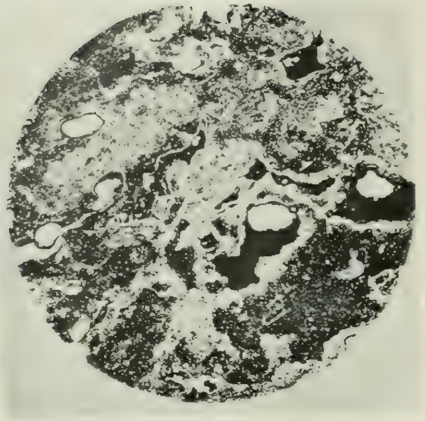


Fig. 5.

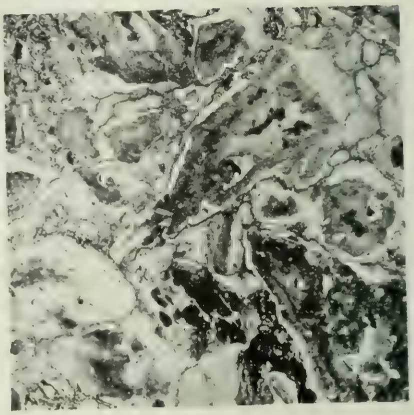


Fig. 6.

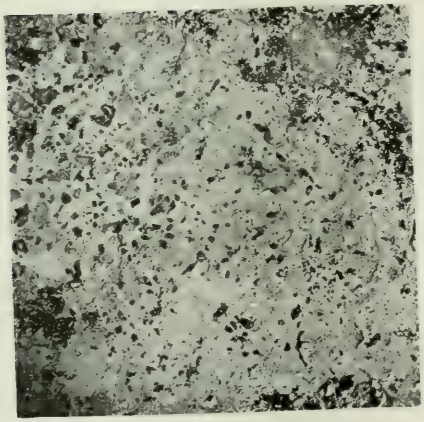


Fig 7

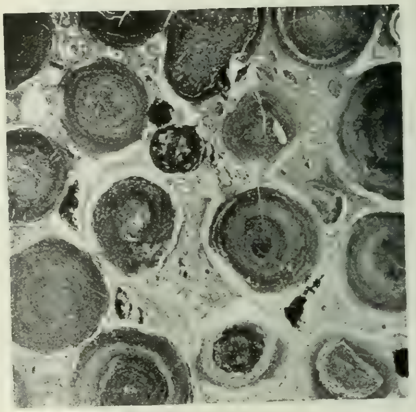


Fig. 8.

FIG. 7. Polished surface of bauxite laterite from French Guiana. Black patches are secondary ferric hydrate, intimately associated with which are groups of gibbsite crystals, also secondary. The grey portions are really pink amorphous aluminium tri-hydrate, with conchoidal fracture coloured by a trace of ferric hydrate. This has been converted partly into pure white, earthy, permeable aluminium di-hydrate, the reticulation of which is seen to traverse the whole of the rock. Magnified 2 diameters.

FIG. 8. Polished surface of pisolitic laterite from Ashanti. Many of the pisolites are almost perfect, having suffered little by secondary action. Much of the cement has been dissolved and re-deposited, the later material being lighter in colour than the original cement, i.e., less ferruginous. Several open passages (black) are to be seen. Magnified 3 diameters.

FIG. 9. Polished surface of pisolitic laterite from Dutch Guiana. This was cut along the course of an old secondary passage now re-filled; this is indicated by the speckled portion running from the low left-hand to the upper right-hand corner with a break where the passage passes below). The formation of this passage involved the partial dissolution of several pisolites and the complete destruction of several. As in all other pisolitic laterite here illustrated the tendency is toward removal of iron, secondary material being lighter in colour than the primary. Magnified 4 diameters.

FIG. 10. Polished surface of pisolitic laterite from Dutch Guiana. This has undergone such extensive change that not one of the original pisolites is intact. Open passages are to be seen surrounded by almost pure white aluminium hydrate. There is evidence of the successive formation and filling of several series of passages. Magnified 4 diameters.

FIG. 11. Polished surface of pisolitic laterite from Ashanti. This consists of an aggregate of pisolites varying greatly in condition along with fragments of older laterite. Many filled passages are to be seen, and the later material is always less ferruginous than the earlier. Magnified 3 diameters.

FIG. 12. Photo-micrograph of section of pisolitic laterite from Surinam. About a quarter of a pisolite is here seen near the middle enclosed in secondary mottled oölitic cement. A portion of the former is bleached. It shows secondary changes which took place before dissolution: radial, spherical, and irregular cracks (white) filled with crystals and micro-crystals of gibbsite. Transmitted light. Magnified 10 diameters.

FIG. 13. Polished surface of semi-pisolitic laterite from Ashanti. In this the tendency to concretionary structure is evident, but no properly developed pisolite exists. Much segregation of alumina (white) as gibbsite and ferric hydrate (black) is seen in one of the individuals. Magnified 2 diameters.

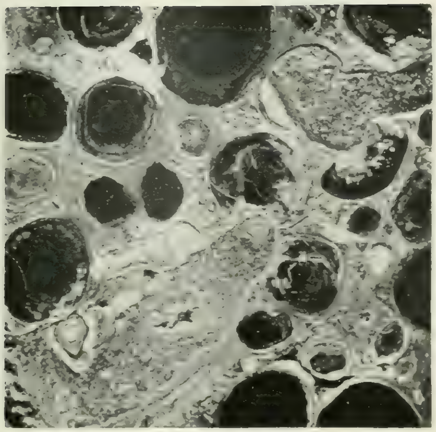


Fig. 9.

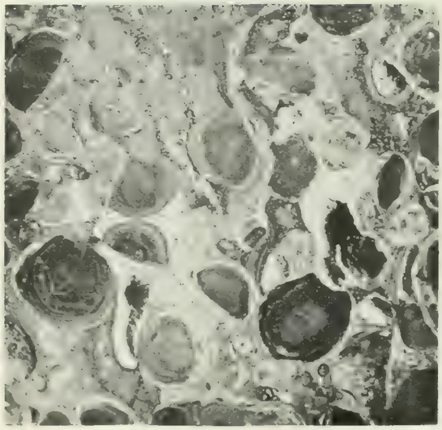


Fig 10.

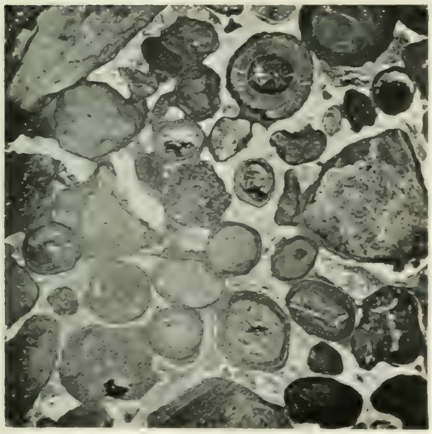


Fig.11.

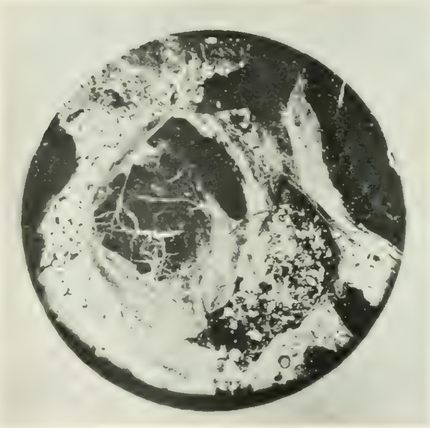


Fig 12.

Fig. 14. Polished surface of laterite from Ashanti, derived from granite. The original lateritic material, which has undergone partial segregation of its constituents, is dark in colour. The system of confluent filled passages or cracks is lighter in colour, and numerous open passages (black) are to be seen. Magnified 2 diameters.

Fig. 15. Polished surface of laterite from Ashanti, derived from granite. This has undergone such extensive secondary change that hardly any of the original laterite remains. It has high porosity (most of the black patches are open passages). The mass of the rock consists mostly of the remnants of the filling of passages that had been dissolved in the material in successive series, each series having been partly or wholly filled before the next formed. Magnified 2 diameters.

Fig. 16. Polished surface of a ferruginous laterite from Ashanti, derived probably from schist. The dark ground-mass is original laterite, in which the speckled appearance indicates partial segregation of the component minerals. The light portions are passages either open or partly filled, and they illustrate one mode in which passages form and fill up with mineral less ferruginous than the matrix. Magnified 2 diameters.

Fig. 17. Polished surface of ferruginous laterite from Ashanti. The numerous passages (black and white, owing to oblique illumination) were formed after laterization was complete, which is quite certain since the mass of the rock has definite structure. This is an example of dissolution without deposition resulting in a very porous laterite. Previous large passages filled with light aluminous material are also to be seen. Magnified 2 diameters.

Fig. 18. Photo-micrograph of laterite from Bombay Presidency, India. This shows outlines of felspar crystals (now entirely gibbsite). They were not sericitized during alteration. This is part of a detrital laterite formed from coarse wind-borne sand, the individual particles of which present great variety of structure. Ordinary transmitted light. Magnified 30 diameters.

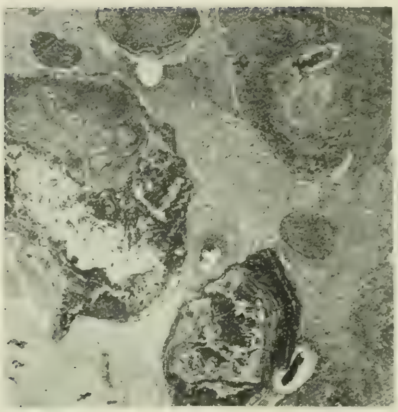


Fig 13.

Fig.14

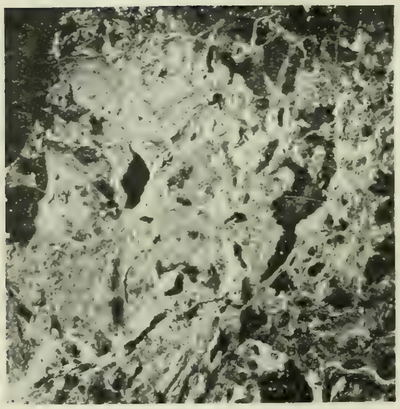


Fig 15

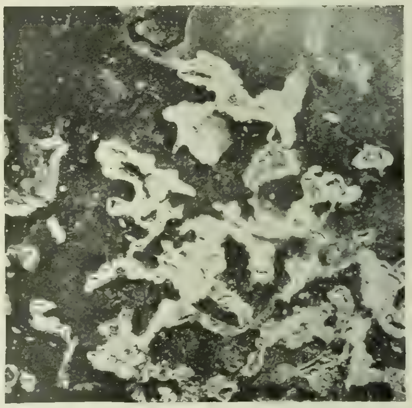


Fig.16

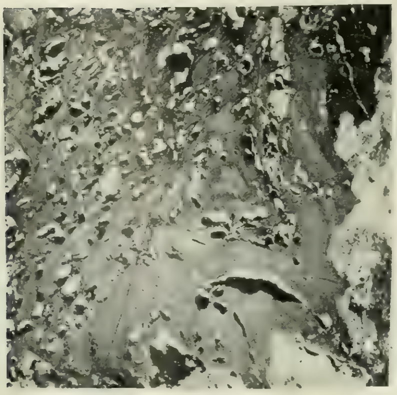


Fig 17.

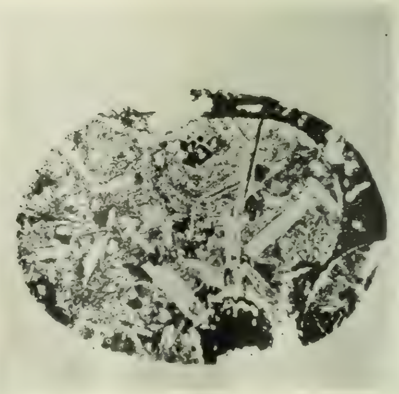


Fig.18.

(*continued from page 172*)
is a photomicrograph of a thin section of the remains of a pisolite enclosed in secondary lateritic material, shows what happens. Part of this fragment has been bleached by the extraction of its iron. The mass of mixed colloids undergoes shrinkage, forming cracks, of which some are radial, some spherical, and others irregular; they are of variable length and width, of different ages, and frequently cross one another. They are never empty but, as far as can be ascertained, are invariably filled with gibbsite. Sometimes this is in well-developed crystals, more frequently it is microcrystalline. Segregation of large, perfectly transparent, colourless gibbsite crystals and black ferric oxide of metallic lustre in the colloid matrix unconnected with cracks is not uncommon. In Fig. 12 oolitic structure is seen in the secondary material; this, however, is not an invariable characteristic, for it is often homogeneous or in layers and frequently contains passages and cavities lined with gibbsite crystals. There is no hard and fast line to be drawn between pisolitic and other laterites: they merge into one another gradually. Fig. 13 represents an intermediate form in which there is undoubted evidence of concretionary action. Secondary change in ordinary laterites proceeds in much the same way as in the pisolitic form. Figs. 14 and 16 illustrate two different types of dissolution and re-deposition in their earlier stages in ordinary laterites. They need no explanation. It is easy to understand that such processes acting for long periods would bring about such complex structure as is depicted in Figs. 6, 7, and 15. Secondary change may take place in many different ways depending apparently upon variations in conditions. As long as laterite is in contact with vadose water its composition cannot be static and its structure is subject to change.

In the great majority of cases the tendency of secondary action is to lower the percentage of iron and to increase that of alumina, while porosity may either diminish or increase. This is not invariably the case, however. Sometimes, after the bulk of the original iron has been removed, an era of iron deposition has supervened which results in secondary ferruginous material darker in colour than the bulk of the rock. Even when laterite is in the zone of non-saturation it may change in composition owing to leaching of iron; alumina does not appear to be appreciably affected. In that zone the tendency must plainly be toward increase in porosity. Gibbsitic laterites have been observed to have suffered in this way by removal of iron and become so friable that in places they fall to a powder of gibbsite crystals even on slight pressure. No matter what may be the source of the lateritic constituents originally deposited and no matter what the iron alumina ratio in them, secondary action is capable of removing and frequently does remove the bulk of these hydrates, substituting others, altering structure and modifying the composition to such an extent that the final laterite bears very little similarity in appearance, structure, or composition to that originally deposited, and obviously its composition cannot possibly bear any relationship whatever to that of the crystalline rock from which it is said to be derived. That basalt should yield a ferruginous laterite and syenite an aluminous one is considered normal, but we have numerous examples of the very reverse which no amount of ingenuity or sophistry can ever explain until preconceived theories are replaced by conclusions based on observation.

Chapter VII.—The Iron-Alumina Ratio in Laterite.

Laterite as at first deposited is an amorphous mixture in which iron minerals usually greatly predominate over hydrates of aluminium. We have seen that secondary change generally reverses this state of affairs, the alumina being in excess later. In the younger lateritic deposits invariably more iron is found in the upper than in the lower part of the same deposit. As its age advances we find the lower part frequently more ferruginous than the upper. This is explained by the leaching of iron owing to its reduction by organic acids and removal in solution as ferrous bi-carbonate which passes down to the vadose water. Excess of carbonic acid and humic acid with absence of oxygen are the conditions necessary in rain-water solutions before iron can be removed, conditions which do not favour the dissolution of alumina. The lateritic layer must of course also be porous. The reversal of any of these conditions prevents iron being dissolved. In the laterizing zone it seems that ferric and aluminium hydrates may be dissolved simultaneously but, except as amorphous hydrates, they do not appear to be precipitated simultaneously. That one is dissolved out of laterite without the other is also certain under some undefined conditions. Loose ochreous ferric hydrate is frequently found in passages the walls of which are rough and plainly being dissolved. In other cases we find white dusty aluminium hydrate also in rough-walled passages. These certainly are residues left by solvents and are not precipitates from solutions. Iron and alumina when precipitated together from solution in passages coat the walls as successive layers of amorphous mixture. Alumina precipitated alone separates as gibbsite quite unmixed with iron minerals. Iron sometimes separates apparently pure in minute crystals filling cracks caused by shrinkage of colloids, but it is not certain that this is not the result of segregation. At other times iron separates from solution apparently free of alumina as a glistening lining in passages near the surface, but the great bulk of such material contains much alumina.

That iron should predominate over alumina at first is quite natural, since it is so readily precipitated by oxygen. Ferric hydrate is more readily dissolved also, so it is not at all surprising that old laterites are as a rule more aluminous than young ones. The microscope shows very distinctly in many old aluminous laterites that the iron present is only the undissolved residue of a much larger quantity previously present, and in other cases that it is the result of secondary deposition in the passages of a mass from which the original iron had been almost completely leached.

The material in which laterization usually commences contains practically no iron in any form. All the primary iron of laterite comes from outside sources and may all be removed at a later stage in its history. At no stage can the composition of laterite be regarded as static. The ferruginous laterites of to-day may easily become the bauxites of future generations. Take the case of the Arkansas bauxites. Will any geologist assert that they were not ferruginous when deposited? It is almost ridiculous to think so. If they were, we should to-day have beds of similar composition being deposited. None such exist. The Arkansas bauxites were almost certainly ferruginous when formed. These Tertiary laterites passed down into the zone of permanent saturation at the period when the sediments that overlie them were deposited. All rocks, and more especially permeable ones, remaining for a normal period in the zone of permanent saturation, are leached of iron. It is thus quite evident that the present composition of bauxites such as those of Arkansas are what we should reasonably expect. When ancient laterites are ferruginous there must be some reason. In some cases it is explained by their having been covered by lava-flows which protected them from leaching. In other cases they may have passed down through the zone of permanent saturation so rapidly that only an insignificant amount of iron was leached. In this connection it is worth remarking that the structure of pisolitic bauxites is identical with that of pisolitic laterites. A wood-cut of a photograph of the former appearing in a paper by Mr. C. Willard Hayes should be compared with Figs. 8 and 9 herewith. The similarity in both original structure and the results of secondary change is very striking.

The ratio between the amount of ferric and aluminium hydrates in laterite is therefore seen to be determined by factors quite unconnected with the ratio between the iron and aluminium contained in the original rock the place of which it takes. The variations of the iron-alumina ratio in any laterite may be very great at different stages of its evolution and they arise mostly through the facility with which, under favourable conditions, iron may be dissolved and precipitated.

Chapter VIII.—The Origin and Structure of Bare Laterite Sheets.

On the surface of plateaux and extensive gentle slopes we frequently find continuous lateritic sheets developed. The maximum vadose water-level in such situations is often at the surface, when they are swampy after the ground reaches a condition of saturation, and they support vegetation in profusion. With increasing iron content and consequent hardening of the laterite, fertility diminishes until only the sparsest vegetation can exist. Then the soil, no longer held together by plant roots, is scoured away by torrential rains leaving large areas of rock bare and rough. It is reddish brown in colour and hardens considerably, being almost always ferruginous. When the rainy season comes round and the ground reaches saturation vadose water emerges on the surface and remains there, filling every hollow. The passages through which it rises are not necessarily situated at the lowest points. This water, as previously stated, seizes oxygen, and colloidal ferric and aluminium hydrates separate out usually along with hydrous silicate of alumina. These attach themselves to the rough surface like a coat of paint, mostly collecting in hollows. A fresh coat is placed in position annually, and gradually a skin forms over the entire exposed surface. The passages by which water wells up are gradually closed owing to the deposition of layers of hydrates at the beginning and end of the rains. The whole surface is thus hermetically sealed, oxygen cut off, and laterization ceases. This explains why many of these continuous sheets are only a few feet in thickness and though old remain highly ferruginous.

This skin forms only on laterite surfaces, after soil is removed; it obviously cannot form if soil remains. Water-level must also reach the surface. It has been asserted that the sterility of such areas is the cause of the development of this form of laterite. On the contrary, the development of laterite is the cause of sterility. Such a thing as a sterile flat area covered with good soil and wet in the rainy season is utterly unknown in the tropics. Many such areas on which laterite is now forming, and on which vegetation is abundant, have been observed in various parts of Africa. Positive proof that the sterility of such areas is the result of laterization and not its cause is often ready to hand.

From some cause, faulting or other crustal movement, such laterite sheets often develop long fractures, the crust being broken up for considerable lengths over a width of several yards. While the unbroken sheet is barren the line of the fracture supports not only grass but forest trees in abundance.

These laterite areas are sometimes above water-level when the sterile stage is reached. In such cases the surface remains red and rough, no skin developing. When below maximum vadose water-level, skin always develops on bare surfaces and the colour changes from reddish to brown or nearly black. The surface is sometimes strewn with laterite fragments of various sizes. These also are coated with hydrates; some are cemented on to the sheet, and smaller ones, easily moved, form concretions. These differ from pisolites in structure in that pisolites never have a foreign core while ferruginous concretions always have. Even laterite on escarpments or elsewhere, when so situated that vadose water flows from its passages, develops a similar skin.

The lustre of this skin varies with the amount of iron present in it; the more ferruginous the more lustrous, and the more aluminous the duller. This lustre is not confined to the skin but is frequently seen on material lining the passages by which water passes out near the surface. This lustrous form of ferric hydrate is not even confined to laterite; it frequently lines passages in limonite. I have seen many examples in the kidney iron ores found abundantly in small bands in the hills of Eastern Kentucky. This laterite skin is not peculiar to ferruginous but is also found in aluminous laterites. In such it is much less conspicuous, being dull in lustre and very closely resembling the body of the laterite. When ferruginous the skin is darker in colour and much colder in tone than the body of the laterite. The iron mineral it contains is probably limonite, though some examples contain less than the normal amount of water and decrepitate with almost explosive violence in the blow-pipe flame. In some cases at least the iron mineral appears to be turgite.

The thickness of the skin rarely averages more than 1 m.m., but is very variable in some places, being several millimetres thick. In section under the microscope the successive layers in which it was deposited are plainly visible, since they vary considerably in composition. The iron mineral is usually quite opaque, but the aluminous portion in old examples shows micro-crystalline structure, probably gibbsite. The ratio of iron to alumina in the skin is very variable, and the amount of iron present is often much lower than one would imagine judging by the colour.

(*To be concluded*).

Tin and Wolfram in Trengganu.

Though it is the most backward of the native states in the Malay Peninsula, the State of Trengganu has shared in the general prosperity of British Malaya during the past year. Mr. J. L. Humphreys, the British Agent at Kuala Trengganu, in his annual report, states that in spite of the Land Office being, as yet, inadequately equipped for dealing with mining matters, there was considerable prospecting activity during the year. It is hoped that a suitable mining enactment will be passed shortly and the department placed in a better position for dealing with applications. Very large areas of the State remain unprospected, and others are locked up in undeveloped concessions. There is every reason to anticipate a good mining future for the State, when an improvement in the administration shall have provided greater security and improved means of communication. Lieutenant T. J. Newbold, writing as far back as 1839, gives the tin output at that period as 1,000 pikuls (about 60 tons) from Kemaman and 7,000 pikuls (about 417 tons) from the rest of the State; in 1916 the total was the same, but the proportions of output were almost exactly reversed.

Of the tin mines, the lode mine of the Bundi Tin Mining Syndicate, Ltd., on the Kemaman river, is the most important. The output for the year was 3,015 pikuls. The Sungei Ayam mine, lode and alluvial, under the same management, produced 1,110 pikuls. Both concession areas are extensive, and the mines are capable of great development. The Dungun wolfram mine, worked by a Chinese lessee from Dungun, Limited, made an output of 4,314 pikuls (about 257 tons).

NEWS LETTERS.

TORONTO.

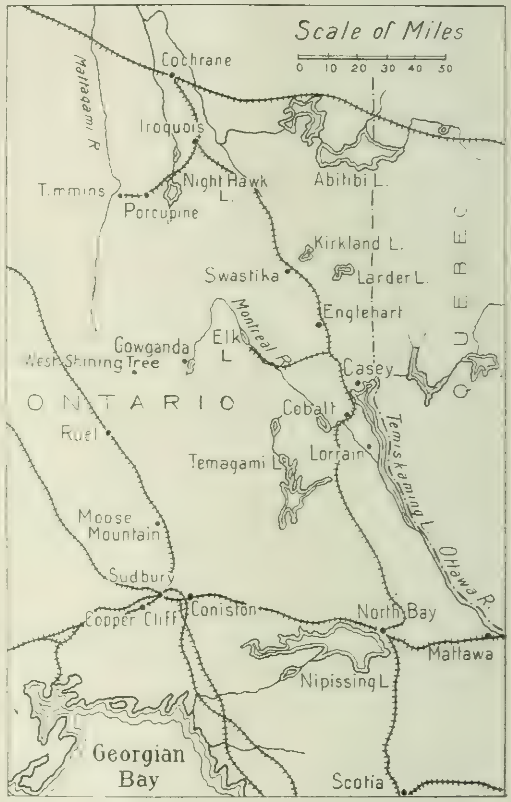
SIX MONTHS' OUTPUT.—The returns received by the Ontario Bureau of Mines for the first six months of the year give the total value of the metallic production of the province at $27,897,322, as compared with $25,886,052 for the corresponding period of 1916. The most prominent feature is the increased value of the silver product, amounting to 10,073,787 oz., which, though slightly less in quantity, shows an increase in value from $6,188,269 in the first half of 1916, to $7,584,439 The gold output shows a small decrease, being valued at $4,586,941, as against $4,822,740.

It was anticipated that the production of gold for the half-year would show a decline as compared with the same period in 1916, owing to labour troubles and labour shortage at Porcupine. Nearly all the mines, including the Hollinger and Dome, have been developing their ore-bodies and increasing their milling capacity in preparation for the time after the war when labour will be more plentiful and operating costs decreased. In the meantime production and dividends have been curtailed. New producers are the Gold Reef and Tommy Burns, at Porcupine, Teck-Hughes at Kirkland Lake, and Miller-Independence at Boston Creek. A single stamp is being worked at the Rognon on Wabigoon lake, in the district of Kenora.

The high price for silver, which averaged 75.44 cents for the half year as compared with 62.53 cents for the same period in 1916, has stimulated production from Cobalt. The lowest New York price was 71.75 cents on March 27 and the highest 78.64 cents on February 15. This advance in value has offset increased mining costs. If the Miller-Lake O'Brien continues shipping at the same rate throughout the year, Gowganda will show a record production for 1917. The increase is attributed to the high-grade vein discovered in the summer of 1916. The Hargrave mine is now shipping regularly. A new shipper this year is the National, formerly the King Edward mine.

The production of nickel-copper matte at Copper Cliff and Coniston shows a small decrease as compared with the same period in 1916, due to shortage of labour. Shipments of copper for the half-year came from three sources, the Tip Top mine near Kashabowie, the Hudson Copper Company at Havilah, and the Kenyon Copper Company, of Massey. The last mentioned operates the Massey mine, where a 100 ton Callow flotation plant is producing 20% concentrate. The production of molybdenite is increasing rapidly. Concentrators are now in operation at Renfrew, Mt. St. Patrick, and Ottawa, and in the half-year treated ore from 13 different mines. At Orillia and Belleville 80,334 pounds of ferro-molybdenum worth $200,835 was produced. Smelters at Galetta and Kingston produced 912,934 pounds of pig lead worth $114,953 from Ontario ores. The Kingston Smelting Company also treated 1,895 tons of lead ore from the United States. Ontario ore came from the Galetta and Frontenac mines.

PORCUPINE.—The Hollinger Consolidated and the Dome Mines have discontinued the publication of monthly statements of production, and little information as to their operations is now obtainable. Both companies are known to be steadily pushing development, the working force of the Hollinger having been largely increased. The new central shaft of the latter company, having a capacity of 5,000 tons per 24 hours, has been completed, and is in operation, though not to capacity. New crushers have been installed and are working smoothly. Operations have been resumed at the Schumacher, which had been closed down on account of labour shortage. The first unit of the mill has been completely overhauled and new vats are being added, which will bring the capacity up to 150 tons daily. Additional mining equipment is being erected, and the new ball and tube mills when completed are expected to give a total capacity of 300 tons per day. The main shaft will be sunk from its present level of



MAP SHOWING ONTARIO MINING DISTRICTS.

600 ft. to a depth of 1,000 ft. The report of the McIntyre, covering the 15 months ended June 30, shows current assets of $307,137 and fixed assets $4,432,249, with a surplus on hand of $741,903. The depreciation reserve fund is $252,009, and in addition $148,987 is charged to general reserves. A dividend of 5% has been declared. The West Dome Consolidated has ore valued approximately at $1,500,000 blocked out, and is preparing to erect a mill, having $75,000 in the treasury. The drift at the 300 ft. level has been run for 2,500 ft. in ore 4 ft. in width stated to average $10 per ton. At the Dome Lake ore is being stoped from No. 3 vein at the 400 ft. level, where a good lens of ore 80 ft. in length has been proved. Diamond drilling has shown the persistence of the vein to a depth of 600 ft. A rich strike of ore has been made at the 400 ft. level of the Newray, where the vein is 5 ft. wide with gold content stated at upwards of $20 per ton. The Coniagas of Cobalt has taken on option on the Maiden McDonald claim, adjoining the Anchorite which they are operating. It is believed that the veins of the latter enter the property. A 15 ft. vein, stated to assay very high, has been struck in diamond drilling on the Bilsky claim, which is being

worked on option by the Apex. Work has been resumed on the Porcupine Premier, which was an active prospect in the early days of the district. Ore of commercial grade has been found on the 100 and 200 ft. levels. Two wide veins have been uncovered on the surface at the North Davidson, but their gold content has yet to be determined. The McRae property has been closed down after sinking to a depth of 100 ft. The resumption of operations is uncertain.

KIRKLAND LAKE.—This district is steadily growing in importance and attracting more attention from investors. At the Lake Shore the workings have been carried to a depth of 370 ft., and the building of the 80 ton mill is being energetically pushed. It will be financed by the sale of 200,000 shares of treasury stock at not less than 30 cents per share. The Teck Hughes is arranging to install additional crushing equipment, which will increase the capacity of the mill to 100 tons per day. A winze is being sunk to 600 ft. The Canadian Kirkland, which has discovered a number of promising veins in surface work, has called for tenders for a plant to develop the property at depth. The Minaker-Kirkland, having obtained encouraging results from the sinking of test pits, will install a plant and develop the mine to the depth of 200 ft. The shaft of the Wright-Hargraves has reached the 300 ft. level and intersected the main vein in a cross-cut. The United Kirkland, a recently organized company capitalized at $2,000,000, has secured a group of claims known as the Dodge-Ellis, and has put its stock on the market.

COBALT. — The present high price of silver has given a new lease of life to some companies whose ore reserves were regarded as nearly exhausted, by rendering commercially valuable much ore which could not previously be mined at a profit. The majority of the mines are now treating their accumulations of tailing by the flotation process. The companies which have installed or are now putting in flotation plants of 100 tons capacity or more are as follows: Buffalo, 600 tons per day; Coniagas, 500; McKinley - Darragh, 300; Nipissing, 300; Dominion Reduction, 200; Northern Customs, 200; National, 100; total daily capacity 2,200 tons. The Nipissing, during August, mined ore of an estimated net value of $293,116 and shipped bullion from Nipissing and custom ore of an estimated net value of $588,254. The total shipments for the current year were valued at $2,057,283, production having shown a steady increase since March. The Mining Corporation of Canada is making a strong push for the first place in the list of shippers so long held by the Nipissing. It is producing approximately 350,000 oz. per month, or at the rate of approximately 4,000,000 oz. annually. The La Rose Consolidated is taking low-grade ore from an open pit sunk between two old veins from which high-grade ore has been extracted. The pit is now about 60 ft. deep and 80 ft. wide, so that a very large tonnage of ore is available. The McKinley-Darragh is another company which has a large amount of milling rock which can now be handled profitably. It is increasing its milling capacity to 500 tons per day, and improving its hoisting facilities. A new high-grade vein 4 in. wide has been cut on the 350 ft. level. An examination of the Timiskaming property was recently made by Balmer Neilly, mining engineer, whose report placed the total ore reserves at between 400,000 to 450,000 oz., taking into account only positive ore. This was not satisfactory to the shareholders, who have ordered a second examination by Douglas Mutch, of the Hudson Bay mine, to include an estimate on probable ore contents. The Cobalt Provincial, with ore reserves estimated at 148,000 oz., has been re-opened.

CAMBORNE.

DIAMOND-DRILLING.—The diamond drill has evidently come to stay as a necessary part of the equipment of our mines, and the two already in the county have done and are doing good work. The drill owned by East Pool has been lent to Dolcoath, where it is being employed in the eastern section of the mine at the 510 fm. level. It is rumoured locally that a wide channel of ore ground has been passed through at this point, but no information as to values is officially available. At Geevor, the other drill has recently proved the existence of two promising lodes, which will doubtless be developed as speedily as possible. The improvement generally at this mine must be gratifying to Mr. Oliver Wethered, whose faith in the property and in the prospects of Cornish mining generally, if properly handled, is proverbial. This drill has now been lent to the Porkellis mine, formerly known as Basset & Grylls, in the Wendron district, which is another of Mr. Wethered's properties. A considerable tonnage of payable ore was proved before the drill was brought to the mine.

MAN-POWER AND ROCK-DRILLS.—The likelihood of a continuation of a dearth of miners for a long time after the close of the war, and the proved necessity for bolder development programmes in the future, make the consideration of the provision of larger air-compressor plants a matter of prime importance at the present time. Very few of our leading mines are adequately equipped in this respect. The training of the hand-drill miners in the skilful use of the rock-drill is also a matter which should be tackled concurrently. Rock-drill men at present are earning high wages in Cornwall, and the larger the number of men in a position to make these high wages the less becomes the likelihood of labour troubles and the emigration of Cornish miners after the close of the war. So long as the men are giving value for the high wages earned, they should be encouraged in this direction. The recent visit of Sir Lionel Phillips (the head of the Government department for the development of home mineral resources) to the county may, it is generally hoped, have convinced him of the possibilities of the Cornish mining industry, and it is expected that his first move will be in the direction of securing increased man-power for the mines, as this is a matter of very pressing urgency at the present time.

ROYALTIES AND WAGES.—At last the trades-union movement seems to have caught on with the Cornish miner, and the Workers' Union is fast becoming an organization which will have to be recognized in the future. At a recent meeting of this organization, reference was made to the royalty question, and, in forcible language, attention was drawn to the royalties paid to the landowners, in some cases for the privilege of making losses and for developing their properties. The suggestion was put forward that if the amounts paid in royalties were available for the payment of wages, the wages question would mainly disappear. Of course, the suggestion that no royalties should be paid under any circumstances is not feasible under present conditions, for even if the State owned the mineral rights, royalties would have to be paid. But there is need for an active campaign in favour of the abolition of royalties when, in spite of good management, no profits are being earned, or alternatively, the lords should contribute toward the cost of special development schemes.

TINCROFT.—This property is now being worked at a fair profit, thanks to favourable developments and to the high price for crude arsenic, which is now fetching over £80 per ton. It is anticipated that by the end of the year the profit earned will be sufficient to pay off the company's overdraft at the bank, so that the new capital recently secured will be wholly available for development purposes and as a reserve.

SOUTH CROFTY.—The intersection of a mineralized stringer in the bottom cross-cut put out in search of the Rogers lode lead to the usual crop of rumours that that now famous lode has been found. Everyone continues to hope that the management's energetic exploration policy may be rewarded, but it looks uncommonly as though the lode at this horizon may be hardly recognizable.

CHINA-CLAY TRADE.—There is every reason to believe that the trade protective organization which is being formed under the title of Associated China Clay Ltd. will be generally supported by clay producers, both large and small. The main reason for its formation is that, during periods of depression, the unrestricted competition between the various producers has involved severe cutting of prices. By pooling the outputs of the various firms, the control and maintenance of prices will be attained, while a central organization can better safeguard the interests of the industry, develop to the utmost extent a valuable raw material, and extend its uses by opening up new markets.

GRENVILLE.—It was common knowledge that this mine was being operated at a loss, but few expected so large a deficit as £10,045, excluding depreciation, for the six months ended June 30 last. The main cause for this loss was the fall in the yield, which for the period under review was slightly less than 23 lb. of black tin per ton. Shortage of labour and the high price of materials are also stated to be contributory causes, but the latter must have been largely off-set by the rise in the price received for the company's produce. This mine needs to be handled on bolder and more progressive lines ; the directors are good business men, but they lack technical knowledge. First-class technical guidance costs money, but knowledge and experience always do. The outlay on such guidance would surely justify itself. Working costs at Grenville are too high, bearing in mind the limited development and the absence of royalties and local rates, and could doubtless be much reduced even in these exceptional times. The manager speaks cheerfully of some of the developments. It is to be hoped that water troubles will not retard the work in the bottom of the mine this winter. The principal points of development just now are the 395 fm. level west of Fortescue's shaft, which should shortly intersect the main shoot of ore. It is a noticeable feature that this shoot has been getting smaller with depth. At the 276 fm. level, east and west, payable ore has been found, and it is hoped that both above and below a continuation of good results will be obtained. The western section of the property (Goold's) is also being explored in the shallow levels with promising results.

PERSONAL.

A. CHESTER BEATTY has returned to England.

W. M'C. CAMERON has been appointed Deputy Director of Aeronautical Supplies and Production, at the Air Board.

PROFESSOR H. C. H. CARPENTER, professor of metallurgy in the Royal School of Mines, is the new president of the Institute of Metals.

HUBERT CARTWRIGHT has left the Owl mine, Gatooma, Rhodesia, for this country in order to "join up."

G. M. CLARK has been elected president of the South African Institution of Engineers for the year 1917–18.

PROFESSOR L. H. COOKE is slowly recovering from the serious street accident of which he was a victim in June last, but is not yet able to resume his lectures on surveying at the Royal School of Mines.

W. R. EAMES, of the Dorr Company, is visiting South Africa.

LIEUTENANT J. L. GALLARD has been home from the front on short leave.

H. P. GREENWOOD is the manager of the newly erected copper rolling mills of Metal Manufactures, Limited, at Port Kembla, New South Wales.

E. M. HAMILTON has gone to Pachuca, Mexico.

A. A. HARRIS is expected from Bolivia.

ARTHUR HOLMES, Demonstrator in Geology in the Royal School of Mines, has received the degree of D. Sc. We have on several occasions quoted Dr. Holmes' work on the geology of various parts of South Africa.

CHARLES HUNTER has been appointed manager of the Kintyre Coal & Oil Co., Campbelltown, Scotland.

T. J. JONES is back from Russia.

LIEUTENANT FRANK M. LUSH has left for Egypt.

J. MALCOLM NEWMAN, manager of the Larut Tin Dredging Co., has joined the Australian Imperial Forces.

ASKIN NICHOLAS has left New South Wales for the United States on business connected with his slime filter.

JAMES PARK is home from West Africa on leave for a few months.

EUGENE SCHNEIDER, of Creusot, France, is president-elect of the Iron and Steel Institute.

ERNEST E. THUM has joined the editorial staff of *Metallurgical and Chemical Engineering*. His work at Anaconda, Great Falls, and Tooele is well known.

J. B. TYRRELL has gone to Newfoundland.

LESLIE URQUHART has returned from Russia.

MAURICE DE VERNEUIL, of Paris, has been elected a director of the Central Mining and Investment Corporation, in succession to the late Georges Rouliot.

T. WEIR is expected from Jos, Nigeria.

H. F. WIERUM has returned to the United States from Mount Lyell, Tasmania.

ERNEST WILLIAMS is examining the Kimmeridge oil shales in Dorset for the Ministry of Munitions.

C. O. WRAITH, lately with the Leeuwpoort Tin Mining Co., in the Northern Transvaal, has been gazetted 2nd Lieutenant in the Royal Engineers.

GEORGE J. YOUNG, lately professor of metallurgy in the Colorado School of Mines, and formerly professor of mining in the Nevada School of Mines, has joined the staff of the *Mining and Scientific Press*.

We regret to record the death of SIDNEY H. FARRAR, one of three brothers well known in connection with South African mining. He was a nephew of the Howards, the machinery makers of Bedford, and with his brothers founded in 1876, with the help of James Howard, the firm of Howard, Farrar & Co. for the purpose of conducting a machinery and engineering business in South Africa. His first activities were in the De Kaap goldfield, and, later, with George and Percy, he went to the Rand in its earliest days. Subsequently the Farrars developed the East Rand Proprietary Mines. Sidney was a mechanical and civil engineer rather than an administrator or company director. He was elected Associate Member of the Institution of Civil Engineers in 1887, and full member in 1891. Probably his last work was the designing of ventilating apparatus for the tunnelling operations at the Front. Mining engineers in London have to thank him for his services in founding and conducting the Mining and Metallurgical Club.

METAL MARKETS

COPPER.—The interest in this metal has centred round the question of the price to be fixed by the United States Government. This has now been established, after lengthy examination of producing costs, at 23½ cents, which approximates fairly closely to the market quotation of the past few weeks of 24 cents to 25 cents. When compared with the official price of standard copper on the London Metal Exchange of £110-£110. 10s., the situation is highly unsatisfactory, and an adjustment on this market to a lower figure will have to be made to bring prices into more correct relation. The English official price of electrolytic copper is now £125-£121, as compared with £137-£133 for the beginning of September. Stocks in the hands of manufacturers both here and in America are low; this will no doubt be remedied at once, now that the uncertainty as to price is out of the way. Little light is forthcoming as to the American labour situation. It is, however, understood to be improving.

Average prices of cash standard copper: September 1917, £117. 15s. 0d.; August 1917, £122. 10s. 5d.; September 1916, £114. 1s. 5d.

TIN.—The daily fluctuations have been small, and the market has been steady throughout the month around £245 for cash. The situation in the Straits is under strict control, and sales have proceeded regularly. In Batavia, however, high prices have ruled, and the bulk of the business has been done with America, where owing to the British control of the metal, prices are far over London parity. The statistical position is favourable. London stocks are depleted, although large arrivals are just announced, and the estimate of American deliveries is in excess of normal. The visible supply at the end of September is given as 19,575 tons. English tin is firm on account of export permits having been issued more freely, and a good trade is being done for export with allied countries. Home trade is more active, although still far from satisfactory.

Average prices of cash standard tin: September 1917, £243. 19s. 5d.; August 1917, £243. 18s. 8d.; September 1916, £171. 8s. 4d.

LEAD.—The official prices continue to be £30. 10s. to £29. 10s. Production should be somewhat stimulated by the high price of silver. In America the price was lowered to 8 cents per lb., and transactions are reported at even a lower level; but values are fluctuating, as the latest quotation is 8·125 cents. Shipping facilities from Spain have been improving.

Average prices of soft foreign lead: September 1917, £30; August 1917, £30; September 1916, £29. 17s. 5d.

SPELTER.—Spelter has been a stable market, the official price standing at £54 to £50. Trading has been light, but no tendency toward a lower level of prices is apparent. In view of its influence toward a decrease in production, no selling pressure has been felt.

Average prices of good ordinary brands: September 1917, £52; August 1917, £52; September 1916, £48. 15s. 9d.

The Australian Zinc Producers Association quotes zinc dust at £85 to £106 per ton, according to quality and amount, delivered at United Kingdom ports.

SILVER.—The upward course of silver continued throughout the greater part of September, and by the 25th the quotation had risen to 55d. per oz. standard. On and after that date the position eased and with supplies coming on the market the price gradually receded. As we go to press, October 10, the quotation is 45⅛d. Export of silver has been prohibited to Holland, Denmark, Norway, and Sweden.

NICKEL.—£225 per ton. BISMUTH.—11s. per lb.

CADMIUM.—7s. 6d. per lb. COBALT.—11s. per lb.

QUICKSILVER.—£20 to £25 per flask of 75 lb.

PLATINUM.—New, 290s. per oz.; scrap 260s. per oz.

CHROMIUM.—No quotation for chrome ores. Chromium metal 7s. 6d. per lb.; ferro-chrome £70 to £160 per ton according to carbon content.

TUNGSTEN.—Wolfram, 70% WO_3, 55s. per unit. Tungsten powder 6s. 3d. per lb.; ferro-tungsten 5s. 6d. per lb.

MOLYBDENUM.—Molybdenite, 90% MoS_2, 105s. per unit. Ferro-molybdenum, 16s. per lb.

No quotation for aluminium, antimony, manganese.

PRICES OF CHEMICALS. Oct. 9.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d
Alum	per ton	16	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	32	0	0
,, Chloride of, grey	per cwt.	1	18	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	70	0	0
,, Phosphate of	,,	100	0	0
,, Sulphate of	,,	15	10	0
Arsenic, White	,,	115	0	0
Barium Sulphate	,,	6	0	0
Bleaching Powder, 35% Cl.	,,	20	0	0
Borax	,,	37	0	0
Copper, Sulphate of	,,	65	0	0
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		11	4
Iron, Sulphate of	per ton	6	0	0
Lead, Acetate of, white	,,	100	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	46	0	0
Magnesite, Calcined	,,	14	0	0
Magnesium Sulphate	,,	11	0	0
Phosphoric Acid	per lb.			10
Potassium Carbonate	per ton	130	0	0
,, Chlorate	per lb.		2	6
,, Chloride 80%	per ton	65	0	0
,, Hydrate, (Caustic) 90%	,,	400	0	0
,, Nitrate	,,	75	0	0
,, Permanganate	per lb		15	0
,, Prussiate, Yellow	,,		3	6
,, Sulphate, 90%	per ton	65	0	0
Sodium Metal	per lb.		1	9
,, Acetate	per ton	80	0	0
,, Bicarbonate	,,	7	15	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	4	5	0
,, Hydrate, 76%	,,	26	0	0
,, Hyposulphite	,,	22	0	0
,, Nitrate, 95%	,,	27	0	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	7	0	0
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	35	0	0
Sulphur, Roll	,,	21	0	0
,, Flowers	,,	23	0	0
Sulphuric Acid, non-arsenical 144°T.	,,	4	5	0
,, non-arsenical 95%	,,	7	0	0
Superphosphate of Lime, 18%	,,	5	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
July, 1916	733,485	27,602	761,487	3,232,891
August	752,940	28,210	781,150	3,318,116
September	744,881	26,686	771,567	3,277,408
October	764,489	27,850	792,339	3,365,642
November	756,370	26,696	783,066	3,326,253
December	748,491	25,971	774,462	3,289,705
Year 1916	8,971,359	324,179	9,295,538	39,484,934
January 1917	756,997	25,637	782,634	3,324,418
February	696,955	24,366	721,321	3,063,976
March	760,598	26,496	787,094	3,343,363
April	717,598	25,180	742,778	3,155,121
May	753,531	26,034	779,385	3,310,618
June	732,799	26,925	759,724	3,227,101
July	731,848	25,991	757,839	3,219,094
August	731,405	25,253	756,658	3,214,079
September	712,881	25,350	738,231	3,135,807

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1916	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500
October 31	199,330	10,907	6,358	216,595
November 30	196,132	11,118	5,928	213,178
December 31	191,547	11,487	5,194	208,228
January 31, 1917	188,624	11,611	5,591	205,826
February 28	191,095	11,568	6,268	208,931
March 31	190,028	11,494	6,620	208,142
April 30	185,975	11,435	6,314	203,724
May 31	180,168	11,432	5,805	197,405
June 30	175,727	11,258	5,369	192,354
July 31	171,653	11,381	5,223	188,257
August 31	170,817	11,401	5,028	187,246
September 31	171,334	11,601	4,791	187,726

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
July 1916	2,370,244	26 1	17 10	8 0	949,606
August	2,423,669	26 3	17 10	8 1	976,125
September	2,367,793	26 6	18 0	8 3	972,704
October	2,453,437	26 4	17 10	8 2	1,001,843
November	2,389,056	26 9	18 2	8 2	980,387
December	2,349,191	26 10	18 2	8 4	977,481
January 1917	2,337,066	26 10	18 8	7 11	941,520
February	2,153,691	27 3	19 2	7 10	841,259
March	2,430,590	26 7	19 0	7 4	879,351
April	2,235,833	27 2	19 2	7 8	857,710
May	2,405,855	26 4	18 7	7 5	887,527
June	2,288,426	26 11	19 2	7 7	867,639

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1916	1917	1916	1917
	£	£	£	£
January	318,586	296,113	140,579	131,665
February	313,769	289,734	137,739	104,892
March	335,368	300,183	150,987	158,727
April	339,386	297,977	135,976	123,825
May	323,783	299,271	132,976	121,104
June	333,070	302,195	127,107	114,489
July	322,365	288,731	128,574	142,017
August	338,001	294,359	125,143	130,278
September	322,035	...	127,138	...
October	325,608	...	132,577	...
November	317,135	...	130,101	...
December	306,205	...	146,409	...
Total	3,895,311	2,368,563	1,615,306	1,026,997

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
July, 1916	912	91,725	92,637	393,495
August	*	89,522	*	*
September	*	85,978	*	*
October	*	82,732	*	*
November	*	87,322	*	*
December	*	88,205	*	*
January 1917	*	83,962	*	*
February	*	81,810	*	*
March	*	76,171	*	*
April	*	82,144	*	*
May	*	78,165	*	*
June	*	82,600	*	*
July	*	81,166	*	*
August	*	80,181	*	*
September	*	81,761	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1916	1917	1916	1917	1916	1917
	£	£	£	£	£	£
January	89,900	67,627	66,700	50,150	39,000	29,000
February	76,500	65,450	79,050	63,200	30,000	26,000
March	103,600	74,794	76,920	61,200	36,000	41,000
April	60,000	75,139	83,300	62,470	63,000	21,000
May	119,500	65,623	116,230	65,450	19,000	28,400
June	86,000	...	72,200	73,100	18,000	24,600
July	100,600	...	85,400	71,820	23,000	44,000
August	66,800	...	86,000	74,800	24,000	21,000
September	115,100	...	65,450	...	32,000	20,000
October	81,400	...	74,800	...	32,000	...
November	94,000	...	60,300	...	31,000	...
December	96,600	...	73,550	...	111,000	..
Total	1,090,000	348,633	939,900	522,190	458,000	255,000

Production of Gold in India.

	1914	1915	1916	1917
	£	£	£	£
January	193,140	201,255	192,150	190,047
February	185,508	195,970	183,264	180,904
March	191,853	194,350	186,475	189,618
April	189,197	196,747	192,208	185,835
May	193,031	199,786	193,604	184,874
June	192,224	197,447	192,469	182,426
July	195,137	197,056	191,404	179,660
August	196,560	197,984	192,784	181,005
September	195,843	195,952	192,330	183,630
October	198,191	195,531	191,502	...
November	197,699	192,714	192,298	...
December	211,911	204,590	205,164	...
Total	2,340,294	2,369,382	2,305,652	1,657,999

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper Standard	Copper Electrolytic	Copper Best Select'd	Soft For'n Lead	Zinc	Tin Standard	Silver
Sept.	£	£	£	£ s.	£ s.	£ s. d.	d.
12	120	137	135	30 10	54 0	243 10 0	50
13	120	137	135	30 10	54 0	244 5 0	50
14	120	137	135	30 10	54 0	245 10 0	51
17	120	137	135	30 10	54 0	246 10 0	52
18	120	137	135	30 10	54 0	245 0 0	52½
19	120	137	135	30 10	54 0	243 10 0	53½
20	120	137	135	30 10	54 0	243 0 0	54
21	120	137	135	30 10	54 0	244 10 0	55
24	110	130	128	30 10	54 0	247 10 0	55
25	110	130	128	30 10	54 0	247 0 0	55
26	110	130	128	30 10	54 0	245 10 0	54
27	110	130	128	30 10	54 0	246 0 0	51½
28	110	130	128	30 10	54 0	245 0 0	49½
Oct.							
1	110	125	123	30 10	54 0	244 0 0	48¼
2	110	125	123	30 10	54 0	243 10 0	47½
3	110	125	123	30 10	54 0	244 10 0	47½
4	110	125	123	30 10	54 0	245 10 0	46¾
5	110	125	123	30 10	54 0	246 0 0	46¼
8	110	125	123	30 10	54 0	244 10 0	45¾
9	110	125	123	30 10	54 0	244 10 0	45½
10	110	125	123	30 10	54 0	244 10 0	45⅛

Imports of Ores and Metals into United Kingdom.

These figures now include Government imports.

* Statistics not published. Long tons.

	Year 1916	August 1917	Year 1917
	Tons	Tons	Tons
Iron Ore	6,905,936	*	*
Copper Ore	34,492	*	*
,, Matte and Precipitate	43,839	1,735	14,658
,, Metal	111,412	25,037	75,797
Copper and Iron Pyrite	951,206	*	*
Tin Concentrate	33,912	*	*
,, Metal	33,646	1,545	18,993
Manganese Ore	439,509	*	*
Lead, Pig and Sheet	157,985	15,858	86,108
Zinc (spelter)	53,324	7,189	37,965
	lb.	lb.	lb.
Quicksilver	2,556,214	1,175,874	1,702,010

Exports of Copper from United States

These figures are circulated by news agencies and it is not always possible to verify their correctness.

1916	Long tons	1916	Long tons	1917	Long tons
January	21,863	July	35,048	January	25,540
February	20,548	August	34,700	February	21,937
March	24,006	September	28,572	March	51,246
April	[illegible]	October	32,712	April	79,001
May	14,700	November	21,433	May	45,241
June	38,277	December	21,438	June	39,816
		Total 1916	313,277	Total 1917	265,783

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1916 Tons	Aug. 1917 Tons	Year 1917 to date
Bisichi (Nigeria)	473	16	188
Briseis (Tasmania)	467	32	243
Dolcoath (Cornwall)	1,076	68	583
East Pool (Cornwall)*	1,012	82	692
Gopeng (F.M.S.)	1,113	91	602
Malayan Tin (F.M.S.)	1,104	80	520
Mongu (Nigeria)	576	45	376
Naraguta (Nigeria)	523	45	323
N. N. Bauchi (Nigeria)	578	50	355
Pahang (F.M.S.)	2,591	205	1,725
Rayfield (Nigeria)	658	60	410
Renong (Siam)	894	95	676
Siamese Tin (Siam)	906	76	557
South Crofty (Cornwall)*	700	58	459
Tekka-Taiping (F.M.S.)	651	35	277
Tongkah Harbour (Siam)	1,135	92	838
Tronoh (F.M.S.)	1,662	89	699

* Including Wolfram.

Stocks of Tin.

Reported by A. Strauss & Co. Long tons.

	July 31, 1917	Aug. 31, 1917	Sept. 30, 1917
	Tons	Tons	Tons
Straits and Australian, Spot	2,488	2,277	2,031
Ditto, Landing and in Transit	900	1,527	263
Other Standard, Spot and Landing	744	964	947
Straits, Afloat	4,093	4,973	6,420
Australian, Afloat	30	—	—
Banca, on Warrants	—	—	—
Ditto, Afloat	1,817	2,147	1,620
Billiton, Spot	—	—	—
Ditto, Afloat	290	273	300
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,410	1,045	1,050
Afloat for United States	5,145	5,380	4,547
Stock in America	1,722	2,092	2,397
Total Stock	[illegible]	20,678	19,575

Shipments and Imports of Tin

Reported by A. Strauss & Co. Long tons.

	Year 1916	Sept. 1917	Total 1917
	Tons	Tons	Tons
Shipments from:			
Straits to U.K.	27,157	2,000*	21,499
Straits to America	25,943	2,000*	18,077
Straits to Continent	8,487	1,000*	7,790
Australia to U.K.	2,537	—	349
U.K., Holland, and Continent to America	14,863	850	10,285
Imports of Bolivian Tin into Europe	15,116	996	12,911
Deliveries in U.K.	16,862	1,584	10,173
,, ,, Holland	943	79	1,527

* Estimated.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1912	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531	665
February	240	427	469	358	528	645
March	247	510	502	418	547	653
April	141	430	482	444	486	554
May	144	360	480	357	536	497
June	121	321	460	373	510	461
July	140	357	432	455	506	464
August	201	406	228	438	498	526
September	196	422	289	442	535	...
October	256	480	272	511	584	...
November	340	446	283	467	679	...
December	310	478	326	533	654	...
Total	2,540	5,103	4,708	5,213	6,594	4,465

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons
January	4,121	4,983	4,395	4,316	3,558
February	3,823	3,555	3,780	3,372	2,755
March	3,562	3,839	3,653	3,696	3,286
April	4,066	4,087	3,619	3,177	3,251
May	4,319	4,135	3,823	3,729	3,413
June	3,993	4,303	4,048	3,435	3,489
July	4,245	4,582	3,544	3,517	...
August	4,620	3,591	4,046	3,732	...
September	4,379	3,623	3,932	3,636	...
October	4,409	3,908	3,797	3,681	...
November	3,976	4,085	4,059	3,635	...
December	4,614	4,351	4,071	3,945	...
	50,127	49,042	46,767	43,871	19,752

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1915	4,918	£448,362	£90 14 6
Year 1916	4,668	£478,194	—
January 2, 1917	176	£17,677	£100 8 10
January 15	160¾	£16,681	£103 15 5
January 29	152	£16,095	£105 17 10
February 12	182¼	£20,649	£113 6 1
February 26	176¾	£19,700	£111 9 3
March 12	179	£20,468	£114 7 0
March 26	161¾	£19,875	£122 17 8
April 10	179	£22,024	£123 2 0
April 23	169	£21,429	£126 16 0
May 7	167	£22,248	£133 4 6
May 21	168¼	£23,772	£141 5 9
June 4	168	£22,474	£133 15 6
June 18	158½	£21,915	£138 5 4
July 2	159½	£21,661	£135 16 1
July 16	144¼	£18,896	£130 19 11
July 30	168	£23,225	£138 5 0
August 13	160¼	£21,757	£135 15 4
August 27	156½	£21,429	£136 18 6
September 10	160¼	£21,784	£135 18 9
September 24	153	£21,448	£140 3 9

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Oct. 5, 1916 £ s. d.	Oct. 5, 1917 £ s. d.
RAND:		
Bantjes	15 0	2 6
Brakpan	4 10 6	5 10 0
Central Mining (£8)	7 0 0	6 2 6
Cinderella	6 0	4 0
City & Suburban (£4)	2 0 0	1 7 6
City Deep	4 10 0	3 12 6
Consolidated Gold Fields	1 12 0	1 17 0
Consolidated Langlaagte	1 7 0	1 2 0
Consolidated Main Reef	19 0	16 0
Consolidated Mines Selection (10s).	1 3 6	1 8 0
Crown Mines (10s)	3 0 0	2 13 9
Daggafontein	16 6	17 0
D. Roodepoort Deep	12 6	12 6
East Rand Proprietary	17 0	7 0
Ferreira Deep	1 7 6	17 6
Geduld	2 8 0	2 0 0
Geldenhuis Deep	1 3 0	1 0 6
Gov't Gold Mining Areas	2 12 3	3 12 6
Heriot	2 8 9	1 15 0
Jupiter	8 0	4 0
Kleinfontein	1 9 9	1 4 6
Knight Central	12 6	3 0
Knight's Deep	1 8 9	16 3
Langlaagte Estate	17 0	15 0
Main Reef West	6 3	3 0
Meyer & Charlton	5 2 6	5 5 0
Modderfontein (£4)	18 17 6	21 17 6
Modderfontein B	6 17 6	8 0 0
Modder Deep	7 7 6	7 2 6
Nourse	1 3 0	18 9
Rand Mines (5s.)	3 15 6	3 2 6
Rand Selection Corporation	3 15 6	4 8 9
Randfontein Central	11 9	11 0
Robinson (£5)	16 3	18 9
Robinson Deep	1 13 9	1 7 6
Rose Deep	1 2 6	18 9
Simmer & Jack	6 6	6 0
Simmer Deep	4 3	2 6
Springs	3 6 3	3 12 6
Van Ryn	2 0 0	1 13 9
Van Ryn Deep	3 8 0	3 7 6
Village Deep	1 13 0	1 1 3
Village Main Reef	16 3	13 0
Witwatersrand (Knight's)	2 13 0	1 18 9
Witwatersrand Deep	1 4 6	8 0
Wolhuter	11 0	8 0
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	13 9	1 1 3
Sheba (5s.)	1 9	1 6
Transvaal Gold Mining Estates	1 2 6	18 9
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	12 0 0	13 5 0
Jagersfontein	3 17 6	4 10 0
Premier Deferred (2s. 6d.)	5 7 6	7 10 0
RHODESIA:		
Cam & Motor	10 9	10 0
Chartered British South Africa	12 9	16 0
Eldorado	9 6	7 6
Falcon	14 0	18 6
Gaika	9 6	8 3
Giant	7 9	7 0
Globe & Phœnix (5s.)	1 10 0	1 13 9
Lonely Reef	19 6	1 6 6
Rezende	8 9	2 17 6
Shamva	1 9 6	1 16 3
Wanderer (3s.)	1 3	1 6
Willoughby's (10s.)	4 9	6 3
WEST AFRICA:		
Abbontiakoon (10s.)	6 3	4 9
Abosso	9 6	7 6
Ashanti (4s.)	18 0	1 1 9
Prestea Block A	8 6	5 6
Taquah	1 0 0	17 9
WEST AUSTRALIA:		
Associated Gold Mines	4 0	3 0
Associated Northern Blocks	3 3	3 0
Bullfinch	4 3	2 0
Golden Horse-Shoe (£5)	1 16 3	2 0 0
Great Boulder Proprietary (2s.)	12 6	12 9
Great Boulder Perseverance	9	9
Great Fingall (10s).	1 3	1 3
Ivanhoe (£5)	2 2 6	2 3 0
Kalgurli	9 6	10 6
Sons of Gwalia	14 3	13 9

GOLD, SILVER, *cont.*	Oct. 5, 1916 £ s. d.	Oct. 5, 1917 £ s. d.
OTHERS IN AUSTRALASIA:		
Mount Boppy, New South Wales	10 0	5 0
Talisman, New Zealand	10 6	12 6
Waihi, New Zealand	1 16 3	1 17 0
Waihi Grand Junction, New Z'lnd	17 6	18 6
AMERICA:		
Alaska Treadwell (£5), Alaska	4 0 0	15 0
Buena Tierra, Mexico	13 0	12 0
Camp Bird, Colorado	7 6	9 0
Casey Cobalt, Ontario	6 0	8 3
El Oro, Mexico	9 6	10 9
Esperanza, Mexico	11 6	9 6
Frontino & Bolivia, Colombia	12 6	12 6
Le Roi No. 2 (£5), British Columbia	10 0	8 0
Mexico Mines of El Oro, Mexico	3 17 6	5 17 6
Oroville Dredging, California	17 6	19 0
Plymouth Consolidated, California	1 0 0	1 3 0
St. John del Rey, Brazil	17 0	18 6
Santa Gertrudis, Mexico	11 6	15 9
Tomboy, Colorado	1 1 6	18 6
RUSSIA:		
Lena Goldfields	1 15 0	1 12 6
Orsk Priority	1 5 6	17 6
INDIA:		
Champion Reef (2s. 6d.)	6 9	6 0
Mysore (10s.)	3 15 0	3 2 6
Nundydroog (10s.)	1 7 6	1 8 3
Ooregum (10s.)	1 1 6	19 9
COPPER:		
Arizona Copper (5s.), Arizona	2 7 6	2 7 6
Cape Copper (£2), Cape Province	4 0 0	3 17 6
Chillagoe (10s.), Queensland	3	3
Cordoba (5s.), Spain	4 0	3 6
Great Cobar (£5), N.S.W.	2 9	2 0
Hampden Cloncurry, Queensland	1 14 9	1 8 9
Kyshtim, Russia	2 13 0	2 0 0
Messina (5s.), Transvaal	11 0	8 6
Mount Elliott (£5), Queensland	4 1 3	4 15 0
Mount Lyell, Tasmania	1 8 3	1 5 9
Mount Morgan, Queensland	1 15 6	1 12 0
Rio Tinto (£5), Spain	63 5 0	66 5 0
Sissert, Russia	1 1 3	1 0 0
Spassky, Russia	2 1 3	1 12 6
Tanalyk, Russia	2 15 0	1 15 0
Tanganyika, Congo and Rhodesia	2 13 9	3 15 0
Tharsis (£2), Spain	5 0 0	5 0 0
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 12 3	1 11 9
British Broken Hill	1 5 0	2 0 6
Broken Hill Proprietary (8s.)	2 14 0	2 10 6
Broken Hill Block 10 (£10)	1 1 9	1 5 0
Broken Hill North	2 4 9	2 17 3
Broken Hill South	8 0 0	9 2 6
Sulphide Corporation (15s.)	1 5 9	1 9 3
Zinc Corporation (10s.)	15 0	1 2 6
ASIA:		
Burma Corporation	4 6 3	4 1 3
Irtysh Corporation	2 7 0	1 13 9
Russian Mining	1 0 0	15 0
Russo-Asiatic	6 1 3	3 13 6
TIN:		
Aramayo Francke, Bolivia	1 6 3	1 13 9
Bisichi, Nigeria	10 0	15 0
Briseis, Tasmania	4 9	5 0
Dolcoath, Cornwall	10 6	10 0
*East Pool, Cornwall	1 16 3	13 9
Ex-Lands Nigeria (2s.), Nigeria	1 6	2 0
Geevor (10s.) Cornwall	8 6	18 9
Gopeng, Malay	1 8 9	1 12 6
Ipoh Dredging, Malay	17 0	15 0
Malayan Tin Dredging, Malay	1 18 9	1 18 9
Mongu (10s.), Nigeria	8 9	15 0
Naraguta, Nigeria	15 0	17 0
N. N. Bauchi Pref. (10s.), Nigeria	7 6	10 9
Pahang Consolidated (5s.), Malay.	11 6	12 0
Rayfield, Nigeria	7 6	12 6
Renong Dredging, Siam	1 18 9	2 13 9
Ropp (4s.), Nigeria	17 0	18 6
Siamese Tin, Siam	2 15 0	2 17 6
South Crofty (5s.), Cornwall	14 6	1 1 6
Tekka, Malay	3 5 0	3 12 6
Tekka-Taiping, Malay	2 6 3	3 10 0
Tronoh, Malay	1 10 0	1 12 6

* £1 shares split into 4 of 5s. each in August 1917.

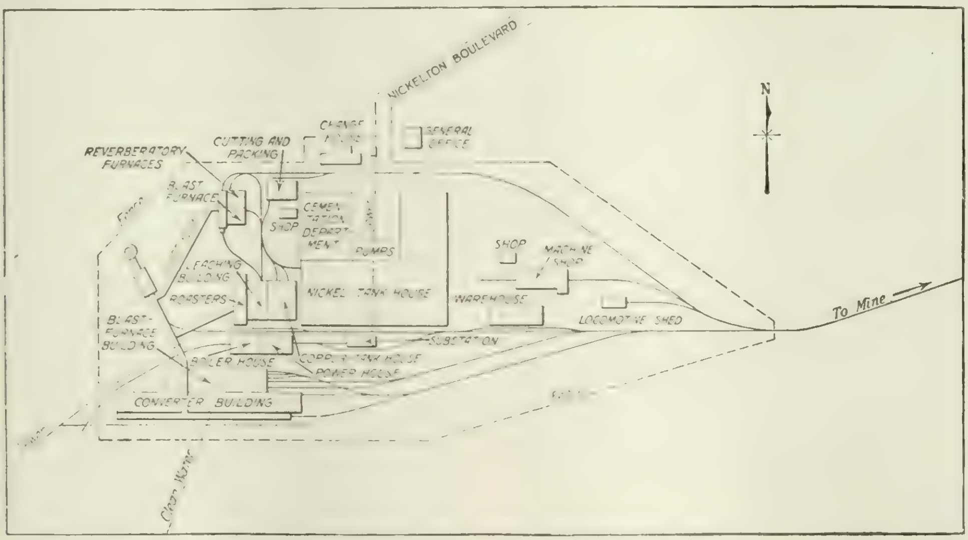
THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE BRITISH AMERICA NICKEL CORPORATION'S PLANT.

In our last issue we reviewed the report of the Ontario Nickel Commission, and gave some details of the British America Nickel Corporation, which is developing the Murray and other mines near Sudbury, Ontario, More recent information is given with regard to the metallurgical plant by E. P. Mathewson, the general manager, in a few notes published in the *Engineering and Mining Journal* for August 25. It will be remembered that the original plan was to erect the blast-furnaces for the production of copper-nickel matte at a point a mile distant from the mine, and the Hybinette electrolytic refining plant at a centre of cheap electric power such as Niagara. More recently, however, it has been possible to make a contract with the Hydro-Electric Commission of Ontario for the supply of power, so the refinery is to be built on the spot. The accompanying plan indicates the arrangement of the plant as finally settled by Mr. Mathewson. We may mention that the town supported by the mine and smelter has been called Nickelton.



Plan of the British America Nickel Corporation's Metallurgical Works.

The ore coming from the mine will be picked on belts and screened over $\frac{3}{4}$ in. grizzlies. The coarse ore will be smelted in blast-furnaces to a 10% copper-nickel matte, and the fine ore will be added to the converter charge. The blast-furnaces will be four in number, 25 ft. in length by 50 in. wide at the tuyeres, and so arranged that if necessary they can be coupled together to give nearly double the hearth area. These furnaces are to be charged from both sides, and they will tap into the usual settlers; the slag will be drawn off into slag cars and transported to the dump by electric locomotives. The converter plant will be larger than usual, and will consist of seven of the latest type of Peirce-Smith converters, with shells 13 ft. in diameter by 30 ft. long, outside measurements. These will be fitted with the Garr silica gun. A portion of the converter slag will be cast on the converter floor, broken up, and used in the blast-furnaces as flux. The remainder will be poured into the blast-furnace forehearths for settlement. The converter matte produced will contain about 80% copper and nickel, approximately 1% iron, the remainder being mostly sulphur. This will be granulated and taken to the refinery, where it will be roasted in mechanical furnaces of the Wedge type, then leached to extract the bulk of the copper, which will be recovered electrolytically, using insoluble anodes. The residue from the leaching will be melted down and cast into anodes, which will be electrolysed by the Hybinette process. Sufficient room has been left for extension in all departments. The smelter building proper will be 160 ft. wide and 360 ft. long; the refining building, 225 ft. wide by 400 ft. long. In addition to these buildings there will be provided shops, changehouse, clubhouse, laboratory, general office, warehouse, power house, substation, etc. The capacity of the plant will be about 2,500 tons of ore per day, representing a nickel production of 10,000 tons per year. Power will be obtained from the Hydro-Electric Commission of Ontario, and all the machinery will be operated electrically. As steam will be required to heat the buildings and solutions, a steam generator plant is also being erected. The total electrical horse-power will be 10,000, of which 1,000 will be supplied by the auxiliary steam plant.

MINERAL RESOURCES OF CHINA.

The *Far Eastern Review* for July reprints an article written by V. K. Ting appearing in a Special China Supplement of the *North China Daily News*. Articles hitherto published on this subject have come from foreigners, so that Mr Ting's paper is of particular interest as being the first from a Chinese author. Mr. Ting is director of the Geological Survey of China, and it is worth noting that he studied under Professor J. W. Gregory at Glasgow.

COAL.—China is undoubtedly rich in coal; there is not a single province in which coal is not known to occur, but some are more favoured than others. Owing to the absence of folding, and the occurrence of normal faulting—two conditions favourable for the preservation of large coalfields—the north-eastern provinces, Shansi, Chihli, Shantung, and Honan, are most important; Shansi is the richest of all. Inner Mongolia and Manchuria are also fairly well supplied with coal, though in the former case it is less known. The north-western provinces are much poorer, but Kansu and Turkestan contain a number of considerable coalfields. The Yangtze valley and the south-eastern coastal provinces have as a whole rather limited resources, and the geological conditions are not favourable for the discovery of new fields. Hunan and Kiangsi form exceptions in this respect; the latter is the Shansi of Southern China. The three western provinces, Szechuan, Yunnan, and Kueichow are known to possess coal in numerous localities, but on the whole they are less important as the seams are usually much thinner and the deposits are broken up into small patches.

The most important coal deposits are of Permian or Upper Carboniferous age. The great coal basins now worked on a large scale in the north all belong to this formation. The coal is always underlain by the great Ordovician limestone and covered by sandstone of continental origin. This is, however, by no means the only coal that occurs in China. The well known field of Fushun in Manchuria is considered to be Tertiary. The famous Tatungfu field in North Shansi and many other basins in Chihli and Inner Mongolia, as well as the coal in the Red Basin of Szechuan are probably Middle Jurassic, while Rhætic coal is found side by side with that of Permian in Kiangsi and Hunan. It is safe to say, however, that the Permo-Carboniferous coal is by far the most extensive. Both bituminous coal and anthracite occur in China, but the latter is probably more abundant, for though the character of the coal is independent of its geological age, the proportion of anthracite is greater in the Palæozoic. Both kinds are generally of excellent quality; the anthracite of Shansi and the bituminous coal of Shantung compare well with the best of their kind in other parts of the world.

With regard to the total reserve of workable coal in China we have no sufficient data to make a reliable estimate, but it is safe to say that as far as present knowledge goes 100,000,000,000 metric tons is a fair minimum figure and the probable real resources may be ten times as large.

The total production for 1915 is estimated at about 18,000,000 tons. Nearly 8,000,000 tons came from modern mines. The table at the bottom of this page contains a fairly complete list.

The German mines of Fangtse and Hungshan in Shantung produced about 560,000 tons in 1914, but stopped in 1915 owing to the war. The 10 million tons left over are attributed to small native mines scattered all over the country. Shansi is easily the biggest producer, Hunan and Szechuan come next; the three provinces together produce about five million tons. From the above statement it is clear that the consumption of coal in China is surprisingly small when compared with her population. The lack of transport is the primary cause of this small output. The use of coal is, however, rapidly increasing, and at present 1,500,000 tons of foreign coal are annually imported. When railway facilities increase, this import is bound to decrease, and the example of the Kailan Mining Administration in exporting coal to the Pacific countries is sure to be followed by the more favourably situated mines. This is especially true of bituminous coal. Anthracite will have to depend largely on domestic consumption, which is also on the increase; for example, in the Lower Valley of the Yangtze where straw and dry grass have been exclusively used as fuel, Shansi and Hunan anthracite begin now to find their way to the market.

IRON.—Roughly speaking we have two fundamentally different classes of iron deposits; (1) deposits of igneous origin, usually found at the contact zone; (2) bedded deposits, some of which are undoubtedly sedimentary, but others of doubtful genetic relations. To the former class belong the famous deposit of Tayeh worked by the Hanyehping Co. Deposits of similar origin but of varying size are extremely numerous, especially in the Lower Yangtze Valley. They are invariably associated with igneous rocks of the diorite type intruded into the upper Palæozoic formations. The ore is usually found at the contact zone, often in limestone, with the development of typical contact minerals as, for example, garnet. Besides the Tayeh deposit, the principal deposits of economic value are the Aocheng (Wuchang) deposit in Hupeh, the Chengmenshan deposit near Kiukiang in Kiangsi, the Taiping and the Fangchang deposits in Anhui, the newly discovered deposit near Nanking, the Tsinalingcheng deposits near the German railway in Shantung, and the Anchi deposit in Fukien. Among the smaller but well known deposits may be mentioned the Tungkuanshan deposit in Anhui, and the Likwoyi deposit in Kiangsu, both of which belong to this class.

The bedded deposits of sedimentary origin are the most famous. The Shansi iron industry, which is certainly the oldest in the world, is the classic example. The ore occurs in the lower part of the Palæozoic coal series near the underlying Ordovician limestone, either

THE CHIEF COAL MINES IN CHINA.

Mine	Locality	Nationality	Production—Tons
Kailan Mining Administration	Kaiping and Lanchow, Chihli	Sino-British	2,971,792
Fushun Colliery	Fushun, Mukden	Japanese	2,034,856
Pingshiang Colliery	Pingshiang, Kiangsi	Chinese	927,463
Peking Syndicate	Chaotso, Honan	British	480,875
Pengshihu Coal Mining Company	Pengshihu, Mukden	Sino-Japanese	275,777
Lincheng Coal Mining Administration	Lincheng, Chihli	Sino-Belgian	259,703
Chungshing Coal Mining Company	Yishien, Shantung	Chinese	244,825
Tsingching Mining Administration	Tsingching, Chihli	Sino-German	179,154
Paoching Company	Yangchuan, Shansi	Chinese	131,396
Liuhokou Coal Mining Company	Liuhokou, Honan	Chinese	91,822
Tungshing Company	Mentoukou, Chihli	Sino-British	80,000

as limonite or hematite, and occasionally hematite pockets are found in the lower limestone itself. The ore has been extensively mined in two regions in Shansi; the one in the Pingtinghow district forming a narrow belt across the Shansi railway, the other in south-east Shansi in the districts of Luan and Tzechow. Unfortunately the ore-body consists usually of irregular lenses, the average thickness of which is probably not much more than 30cm., a fact which excludes the possibility of mining on a modern scale, otherwise the enormous horizontal distribution would give it an immense importance.

The second class of bedded deposits is exclusively found in the Pre-Cambrian rocks. They are usually well bedded and some of them are probably of sedimentary origin, but as the country rock is more or less metamorphosed their genetic relation is somewhat uncertain. These deposits have recently acquired great importance, as the ores found between Pengshihu and the South Manchurian railway are now being worked by the Japanese. The best known deposit is, however, that of Lanchow near the coal mines, but the percentage is unfortunately rather low. The well-known iron ore of Pinghsiang in Kiangsi, and that of the adjacent district Yushien in Hunan, may prove to be of the same nature.

It is impossible to estimate exactly the resources of the Shansi sedimentaries as the lenses are very irregular, but the probable total quantity may be given at 300 million tons. It must be remembered, however, that these are not suitable for modern mining. The reserve of the other deposits altogether amounts also to 300 million tons, of which at least half can be worked by modern methods. The present iron industry is still very backward. The total production of pig-iron in 1915 was about 300,000 tons. Of this 136,541 tons was from the Hanyang Iron Works, and 29,529 tons from the Sino-Japanese Coal Mining Company at Penshihu. The rest are attributed to the small native furnaces in Shansi, Szechuan, Hunan, Yunnan, etc., Shansi contributing about 50%. The Tayeh mine exported in 1915, 298,350 tons to Japan besides supplying the works at Hanyang.

GOLD.—The gold deposits may be divided into four classes: (1) recent alluvium, (2) ancient alluvium, (3) Tertiary sandstone, (4) quartz veins in Pre-Cambrian gneiss and metamorphic rocks. The first is by far the most important, as all the productive mines of Manchuria and Outer Mongolia belong to this class. The four great rivers in Manchuria, the Amur, the Yalu, the Tumen, and the Liaoho, drain large areas covered by gneiss and granite, whence the gold has been washed down, together with other products of erosion, into the tributary valleys. All the great gold mines in Heilungkiang province are situated on the right bank of the Amur river, those of Kirin along the tributaries of the Yalu and the Tumen, and the mines of Mukden in the basin of Liaoho. In Outer Mongolia, they are in the valleys of the Iro, the Shara, and the Kurduri, of all which are tributaries of the Selenga, which flows into Baikal lake. Similar alluvium is found in the Upper Yangtze between Yunnan and Szechuan, in the southern tributaries of the Tarim in Turkestan, and in the smaller streams in Shantung, Honan, and Jehol. As to the second class, we have a unique example of the Wali gold mine on the banks of the Yalung river in Szechuan. The Tertiary sandstone known as the Hanhai formation has a wide distribution in Turkestan and Kansu, and in the Kwenlun and the Nanshan it is often auriferous. In Szechuan, Kiangsi, Hunan, Fukien, north Chihli, and Shantung the gold-bearing quartz veins in the gneiss and phyllite are often worked in a small way; the famous Maha mine in Szechuan and the Pingkiang mine in Hunan both belong to this class. The alluvium worked in Manchuria contains on the average 1·07 dwt. of gold per ton, while quartz veins are not considered workable when the gold content is much less than 6 dwt. per ton. In 1915 the total production was about 200,000 oz.; 120,000 from Manchuria and 60,000 oz. from Outer Mongolia, and the rest from Chihli, Hunan, Shantung, Kansu, Turkestan, Szechuan, Yunnan, Kiangsi, and Honan.

COPPER.—The occurrences of copper ore in China are extremely numerous but few have been proved of value. Genetically these deposits can be classified into five groups: (1) magmatic segregations, (2) contact deposits, (3) replacement and fissure veins, (4) impregnations, (5) sedimentary deposits. The first group is well seen in the Permian basalt of Yunnan, which covers immense areas; whenever this rock outcrops there are sure to be some abandoned mines and heaps of slag, which gave the French engineers erroneous impressions of the mining possibilities along the Yunnan-Tonkin railway. But they are practically without exception very small irregular bodies quite unsuitable for modern working. Similar occurrences are known in the Tertiary porphyries of north Chihli. The second group is always more or less associated with the iron ore, being also due to the contact action of the diorites. They are found scattered in south Hupeh, in the districts of Shingkuo and Yangshing, and may be regarded as of no economic value. The Government mine of Pangshih in Kirin seems to belong to this type; the copper content is usually above 10%, though the amount is limited. The third class is by far the most important, for the famous copper mines in Tungchuanfu in Yunnan are of this character. The ore is of high grade, usually above 8%, and the possible reserve large. The stockworks in the limestone are formed by replacement, while in shaly rocks they are fissure veins. Similar deposits are to be found in the Hueili district in Szechuan. The fourth type is exclusively found in Pre-Cambrian crystalline rocks of south Shansi, and north-west Hupeh. They are usually of low grade, but the reserve reaches sometimes respectable dimensions. The Government mine of Pengshien near Chengtu (Szechuan) is of the same nature. There the ore-bodies are large lenses in the crystalline schists and limestone, the average copper content being about 5%. The last group is of great geological interest. In Yunnan and Kweichow the Lower Triassic sandstone overlying the Permo-Triassic coal measures always contains some copper, usually in the form of malachite, which used to be extensively worked in Tantang in the district of Hsuanhui, Yunnan. Similar deposits are found in the Hanhai formation in Turkestan; for example, the copper mines near Aksu. The present yearly production of copper iu China is about 2,000 tons, mostly from Yunnan, Kirin, Kansu, and Turkestan, the first province supplying about 50%.

TIN.—Tin is at present the most important metal produced in China. The production in 1915 was nearly 8,000 tons, about 6% of the world's total production. Over 80% came from Kokiu in Yunnan; the rest from southern Hunan and Kwangsi. The deposits are invariably connected with granitic intrusions. In the last named region the tin is probably alluvial, but it occurs as lodes in limestone and granite in the districts of Lingwu and Kianghua in south Hunan. In the most important district of Kokiu, it is a residual deposit; the minute crystals of cassiterite are scattered through the limestone not far from the granite and are usually too poor to be mined. But as the limestone is weathered away, a red residual clay is left in which the tin ore is thus concentrated. The lowest workable percentage at present is about 0·1% of cassiterite.

ANTIMONY.—In antimony China occupies a unique position, for since 1908 the country has produced more than 50% of the world's total yield. In 1913 China produced 13,000 tons, that of the whole world being 20,000 tons, while in 1915 China's production increased to 20,000 tons. More than 90% came from Hunan, where the metal is widely distributed. The most important centres are in the valley of Tsekiang in the districts of Shinghua, Anhua, Yiyang, and Paoching. The mineral is usually stibnite, but the oxide occurs also in small quantities. The best known deposit is that of Shikungshan where the ore bed occurs between the quartzite and the upper limestone which are either Lower Carboniferous or Upper Devonian. These beds are folded into anticlines and domes with which the ore seems to have a constant relation. Most of the other Hunan deposits are found in the same horizon, but in Yunnan the Amichow deposit is probably in the Triassic formation.

ZINC, LEAD, AND SILVER.—These three metals are usually associated with one another. Geologically they are of two classes: (1) those in Archæan gneiss, (2) in Palæozoic limestone. The former class is chiefly found in north Chihli and north Shansi, and is usually small in amount, but rather rich in silver; the richest galena from Jehol contains as much as 100 taels per ton. The second class on the other hand is much more extensive, but the silver content is somewhat smaller, averaging about 16 taels per ton. The best known deposit is that of the Government mine of Shuikoushan in Hunan, where the mixed ore of galena and blende occurs in large pockets in the limestone. [A description of this deposit was given in our issue of February last.—EDITOR]. The only other important deposit with a respectable output is that of Kungshan in Tungchwan (Yunnan). Here the principal ores are carbonates. In 1914, 6,000 tons of zinc and 5,300 tons of lead were produced in China, most of it from the Shuikoushan mine. The production was increased by 30% in 1915. The amount of silver produced was insignificant, probably not more than 50,000 oz.

OTHER MINERALS.—China produced in 1915 456,300 lb. of mercury, which came almost exclusively from Kweichow. In the same province there is also a considerable amount of orpiment. Sulphur is made in Shansi, Honan, Hunan, and Szechuan, partly from pyritiferous shale, partly from the sulphide ores of zinc and lead. Among the rarer metals, cobalt, nickel, tungsten, and molybdenum are known to occur in many localities, but the production of these is still quite unimportant.

PETROLEUM AND SALT.—The Standard Oil Co. uudertaking in Shensi has proved to be a disappointment, but the geological conditions seemed from the outset to be unfavourable, as the oil-bearing strata are hardly folded at all. The adjacent province of Szechuan may still prove to be a success, as there exist many anticlines in the Red Basin where natural gas is known to occur in the salt wells. A more close study of the brines may very probably lead to the discovery of potash salts which are badly needed in China for agricultural purposes.

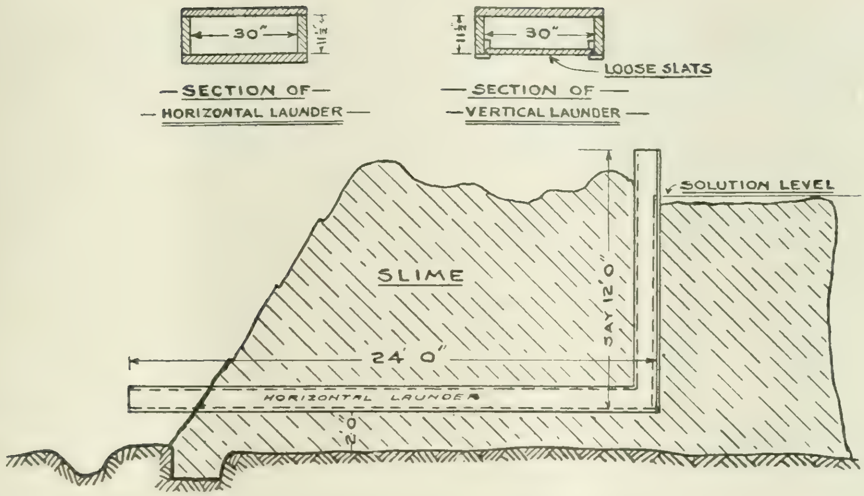
THE CONSTRUCTION OF DAMS FOR SLIME.

The June *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by J. E. Thomas and E. A. Osterloh describing the experience gained in constructing a dam for slime at the Simmer Deep. The ideal slime dam would of course be similar to those used for water reservoirs, but naturally the cost would make the use prohibitive. Slime dams have to be built in the majority of cases from the slime itself, and the most that can be done is to make the outside walls of the heavier slime particles and avoid excess of moisture in their construction.

The site selected for the dam having been surveyed, a trench should be dug at least 3 ft. wide and 1 ft. 6 in. deep on the line which the toe of the outside walls is to follow. The object of this trench is to serve as a preliminary channel along which to conduct the slime pulp, and also, in some measure, to key the walls to the ground. The earth from the excavation should be thrown up on the outer side. The pulp from the slime-residue discharge-pipe should be led along the trench in one direction, that is, either to the right or left of the pipe, which should be at right angles to the line of the trench, until it will no longer flow. It should then be led in the opposite direction, and the heavy partly dried slime from the first-used portion dug out with shovels and packed so as to form a channel at least 21 ft. wide, the lower outside edge of the wall thus formed coinciding with the outside line of the trench. This ensures that the outside walls of the dam will be composed of comparatively solid material, containing little, if any, excess of moisture, a result that cannot be obtained by dragging up wet pulp with scrapers to form the walls. An additional advantage in having just sufficient moisture in this material to render it plastic is that any tendency for cracks to develop is almost eliminated. The operations described should be carried out on each portion of the trench alternately until the channels meet at the side of the dam farthest away from the inflow of pulp.

When the slime in the dam reaches a height of about 2 ft. above ground level, L shaped launders should be installed at suitable places, to drain off any excess of moisture from the surface of the dam. These launders should be made of 2 in. timber and have a section of approximately 2 ft. 6 in. by 11½ in. inside measurements, and arranged so that slats 2 in. thick by 1½ in. deep can be dropped into guides in the vertical portion facing toward the middle of the dam. The guides should be supported at intervals of 12 in. or so by horizontal struts nailed inside the launder. It is now possible to allow the pulp to flow from any part of the surrounding channels to the interior of the dam.

The following system of control has been found by the authors to give satisfactory results. The pulp is allowed to flow along one channel to the side of the dam farthest away from the inflow, and is there led through the inside wall by means of short lengths of pipe to the interior of the dam. When the lower end of the channel becomes choked, another opening is made nearer the inflow, and so on until the whole channel is full. The same procedure is then gone through with the other channel. Meanwhile the slime in the first channel is dug out and packed on to the existing walls. As the outside walls rise they are stepped back about 6 in. every 2 ft. in height and trimmed to form an angle of roughly 50° with the horizontal. The stepping renders any portion of the walls easily accessible for inspection and any necessary repairs. Trimming should be carried out by the ganger in charge of the natives working on the dam, and should be done so as to make the walls straight, any corners being well rounded off. This ensures that the walls will receive



Details of the Slime Dam at Simmer Deep.

a thorough inspection and enables any tendency to bulge to be quickly detected, so that precautions can be taken to prevent the walls giving way. This may be effected by isolating the suspected portion of the wall from the rest of the dam, making a temporary channel further in, while repairs are carried out; by making a new channel altogether, some distance in from the one abandoned; or, in very bad cases, making a new wall by building up an outer wall from heavy slime outside of the original wall. The regulation of the flow into the dam from the main channels should be so arranged that any superfluous water or solution remaining after discharging is finished is kept well away from the walls and not allowed to remain too long at any one particular drainage launder.

In order to enable repairs to be effectively carried out, the authors recommend that two dams, adjoining one another for convenience in working, be used alternately and kept nearly at the same level. Then, if extensive repairs to one dam be required, no inconvenience will be experienced in disposing of the residue from the slime plant, and ample time may be given to making the repairs in a thorough manner by running the pulp to the other dam.

The solution or water from the drainage launders should be led to a special dam, adjoining the slime plant, from which it may be returned to the slime-treatment circuit with a minimum expenditure on pipe and power lines. For this purpose a trench of heavy slime may be built outside and at the base of the main walls so that the solution will gravitate toward the slime plant. This trench, to some extent, acts as an anchor to the toe of the outside walls.

It will be evident that as the vertical portion of the drainage launders and the outside walls approach one another arrangements must be made to carry the launders more toward the middle of the dam. This may be done by attaching another L shaped launder to the top of the first, and so on as the level of the slime in the dam rises. The authors find that a length of 12 ft. is most convenient for the vertical launder, with 24 ft. for the horizontal portion. If the inside walls of the main channels are kept within a foot or so of the vertical launders, the fitting of slats becomes an easy matter. It also enables close observation to be kept on the interior of the launder for any broken slats, etc. Should it become necessary to carry out repairs to the launders, within reasonable reach, they may be cut off from the rest of the dam by building a temporary wall of slime to prevent solution on the surface of the dam interfering with the work. If it should be considered that the carrying out of such repairs may not possibly remedy the defect, it will generally be found cheaper to install a new launder near the one to be abandoned, rather than waste time and labour on a doubtful job. To do this the main channel should be cut through at the level of the slime in the dam, the launder placed in position, and the channel re-made over it. In such cases it will be necessary to extend the outlet of the launder down the side of the wall to the drainage trench. The old launder may be plugged from the outside and filled with heavy slime from the main channel.

When re-starting a dam which has not been used for some time it will probably be found that holes have formed, causing leaks at most unexpected places in the outside walls. The authors have found it useless to try to stop such leaks from the outside, but it can be done from inside by allowing only heavy slime to pour into the hole, meanwhile working a shovel at the inlet to cause the sides to collapse and choke the hole lower down.

It has been noticed that walls built in the manner described show comparatively little erosion even after the heaviest rains. This is partly due to the fine sand in the heavy slime acting as a binder. Care must, however, be taken that the amount of sand present is not excessive, or the walls will crumble away when dry. Slime carrying from 1·5% to 2% fine sand in the total charge yields a heavy portion suitable for making the outside walls. In using the dams it is advisable to do as much as possible of the discharging from the slime plant in daylight. Should it be necessary to discharge at night, the dam should be prepared the previous day so that the solution or water used in discharging will be kept away from the walls. In this connection it might be mentioned that a moisture ratio of 1 : 1 is sufficient when discharging slime pulp.

Two dams, with a total circumference of 6,000 yards to 7,000 yards, built in the manner described, will be found sufficient to receive the residue from a plant capable of treating up to 50,000 tons per month. The labour required to keep them in proper running order consists of an intelligent white man and from eight to ten able-bodied natives, according to the wetness of the season.

Potash from Blast-Furnace Dust. — As mentioned on several occasions in our columns, the discovery that soluble potash compounds are present in the dust from iron blast-furnaces promises to be of wide-reaching importance in that a new and important source of potash is thereby provided. The classical paper on the subject is by R. J. Wysor, published in the February *Bulletin* of the American Institute of Mining Engineers. A paper by H. T. Cranfield appears in the August issue of the *Journal* of the Board of Agriculture, and as this is the first paper published on the subject in England, we quote from it herewith. The author conducted experiments on Northamptonshire ironstone smelted at the Bennerley furnaces, Ilkeston, Derbyshire.

The ironstone contains a small percentage of potash, presumably in the form of silicates. Three samples of Northamptonshire stone analysed gave an average of 0·2% K_2O. Undoubtedly potash is also present in the fuel, but few analyses appear to have been published giving the potash content of coal and coke. One or two which have been placed at the writer's disposal give figures ranging from 0·15 to 0·4% potash. The enormous heat at the base of the furnace, assisted by the action of the lime and fuel, appears to break down the potassium silicates, potassium oxide (K_2O) in the gaseous state being formed. This in turn reacts with sulphates and chlorides present producing potassium sulphate and potassium chloride. These potash salts condense in the cooler regions and pass up the furnace in the form of fine dust. Owing to there not being sufficient air for complete combustion the particles become coated with carbon, and, together with a large quantity of particles of fuel, ironstone, etc., pass over with the gases into the "down-comer," or main down-flue. At the bottom of this flue is a cavity which retains the greater bulk of the dust (about 75 to 85%) in the form of a coarse, black powder. The finer particles, which contain the greater proportion of the potash salts, are carried on into the ovens or round boilers of the Lancashire type, where the gases, being combustible, are burnt, the heat produced being utilized in the production of steam for power purposes. The dust deposited in the ovens or round boilers is brick red in colour and somewhat finer than the black dust. The burnt gases issuing from the ovens carry with them the finest of the dust particles, and a further portion of these collects in the various flues, the gases and probably the finest particles of dust ultimately escaping by the stack. Many of the later-deposited flue-dusts are cream in colour and very bulky. They constitute the richest source of potash.

These potash-bearing flue dusts vary widely in colour and composition, in fact the writer has not yet found two samples alike. The black dusts contain considerable amounts of insoluble ferrous compounds. Insoluble sulphides are also present. Occasionally black dusts are found which contain soluble cyanides, sulphites, and even free alkali; these should be avoided for agricultural purposes. The red dusts are rich in ferric oxide, while many of the cream dusts contain either free lime or calcium carbonate. All are rich in silica and silicates. The potash exists mainly as potassium sulphate with a small proportion of chloride, the remainder being in an insoluble form. The availability of the latter is a subject for investigation. The amount of soluble potash varies very much; in samples which the writer has examined the variation was between 50 to 70% of the total potash. After extracting the flue dust with hot water, evaporation of the extract yields a white residue which contains on an average 70 to 80% potassium sulphate and chloride. Sodium chloride and calcium sulphate constitute the chief impurities in this water-soluble extract.

The following analyses of flue dusts will give some idea of the potash content of typical samples:

Laboratory Number	Colour	Water-soluble Potash %	Total Acid-soluble Potash %
1493	Cream	9·25	15·89
1502	Black	—	3·13
1503	Red	5·92	8·50
1504	Black	1·68	2·97
1504B	Black (burnt)	—	5·12
1573	Black	2·01	3·73
1590	Black	1·23	3·13
1537	Cream	5·69	11·82
1538	Red	4·68	7·58
1539	Grey	5·88	12·46
1566	Light brown	3·82	7·51
1567	Grey	4·70	7·10

The following table gives the potash content of the salt obtained by extracting the flue dust with hot water:

Laboratory Number	Potash (K_2O) content %
1510	40·04
1523	41·27
1589	41·84
1632	39·74

It is difficult at present to give more than a rough approximation of the total amount of potash which could be obtained from this source, but the writer offers tentatively the following figures, which he is at present inclined to believe rather under than over estimate the quantity available: Number of furnaces in full blast in Great Britain 300; quantity (in tons) of flue dust produced per furnace per week: black 20, red 5, cream 1. Assuming the black to contain 2·5% potash, the red 7% and the cream 10%, 0·95 tons of potash per furnace per week would be produced. Each furnace would, therefore yield about 50 tons of potash per annum, this giving for the 300 furnaces a total annual production of 15,000 tons. This represents total potash, of which all may not be available, but at least 50% of this would represent soluble potash.

The writer therefore considers this to be the most important source of potash yet discovered in this country. Only a thorough investigation into the whole question can result in the full benefit of these deposits being obtained for agriculture, but until arrangements can be made and plant erected for the extraction of the water-soluble potash salts, the raw flue dust might be utilized on land which has become very deficient in potash during the past two years.

Steel Sleepers for Mine Rails.—The *Iron & Coal Trades Review* for September 14 contains a description of a method of fixing light rails to steel sleepers, invented by D. Leyshon, of Llwynypia, South Wales. The system is suitable for mine rails or for ordinary surface work. The arrangement is simple and inexpensive; it eliminates the trouble of gauge setting, and tracks can be easily and rapidly laid by unskilled labour. Any suitable section of steel may be used for sleepers, but inverted channel section gives most satisfactory results. Two slots are made near the ends of each sleeper, as shown in Fig. 1, one on each side of rail centre line. As a matter of fact, one cramp only is required at each end of the sleeper and therefore one slot only is used; but for obvious reasons the double

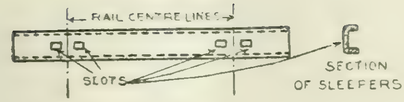


FIG. 1.

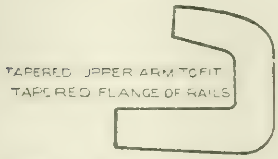


FIG. 2.—ENLARGED DETAIL OF CRAMP.

FIG. 3.—SECTIONAL ELEVATION SHOWING OUTSIDE CRAMP IN POSITION

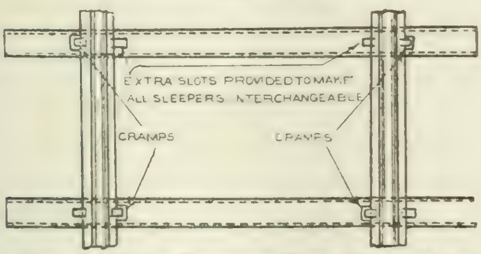


FIG. 4.—PLAN SHOWING TWO SLEEPERS IN POSITION.

slotted end is so convenient that it more than compensates for its small extra cost over a single slotted end. In these slots small U-shaped cramps, shown in detail in Fig. 2, are inserted. The lower arm of the cramp is square with the inside vertical face, while the top arm is slightly tapered to correspond with the tapered upper faces of the rail flanges, thus ensuring perfect surface contact between the rail flanges and the cramp arm. The lower arm of the cramp engages with the underside of the sleeper. As shown in Figs. 3 and 4, the two cramps on one sleeper are arranged on the outside of the two rails, and the two cramps on the next sleepers are arranged on the inside of the rails; by this means the rail gauge is set and the flanges of the rails are securely fixed to the sleepers. In order to lay a track on the above principle the cramps are inserted through the outer slot of each alternate sleeper from the upper side, and the rails are then laid with their outside flanges between the sleepers and tapered upper arms of the cramps, the edges of the outside flanges of the rails also bearing against the inner vertical sides of the cramps, as seen in Fig. 3. The outer vertical side of the cramp bears against the outside edge of the slots in the sleepers. The remaining intermediate sleepers are laid obliquely between those first laid, and the cramps are then inserted through the inner slots so as to overlap and engage the inner base flanges of the rails. The latter sleepers are then knocked or pushed straight into parallel with the first-laid sleepers, when the whole system is perfectly rigid. The rail ends are then connected up with fish plates and bolts in the usual way, or by pins and cotters, the pins passing through the sleepers and rail flanges, if a sleeper is preferred under the rail joints.

Standard Screens.—At the October meeting of the American Institute of Mining Engineers, a paper is to be presented and discussed describing the series of screens for testing purposes, recommended by the United States Bureau of Standards after consultation with many representative societies and trade organizations. We are not able to afford space for the whole paper, and we limit our quotation to the reproduction of part of the main table. The series is founded on metric measurements, but for convenience the corresponding measurement in inches is given. The first column gives the width of opening, the second the number of meshes to the centimetre, the third the number of meshes to the inch, the fourth the diameter of the wire, and the fifth the ratio of the diameter of the wire to the width of opening. The series is calculated from the standard opening 1 millimetre wide. The widths of the smaller openings are calculated by successively dividing 1 mm. by the fourth root of 2, or 1·1892, and the widths of the openings larger than 1 mm. by multiplying by the square root of 2, or 1·4142. It must be remembered when examining this series that the screens are designed for other purposes than those of the mining engineer and metallurgist, and that the Bureau recommends each industry to choose ten or a dozen out of the series most suitable for its own purposes. We refer to this subject in our Editorial columns.

	Width of Opening	Meshes per Centimetre	Meshes per Inch	Diameter of Wire	Ratio Wire to Opening
Millimetres	8·00	1·0		2·00	0·25
Inches	0·315		2·54	0·079	
Millimetres	5·66	1·4		1·48	0·26
Inches	0·223		3·56	0·058	
Millimetres	4·00	2·0		1·00	0·25
Inches	0·157		5·1	0·039	
Millimetres	2·83	2·75		0·81	0·29
Inches	0·111		7·0	0·032	
Millimetres	2·00	3·9		0·56	0·28
Inches	0·079		9·9	0·022	
Millimetres	1·141	5·0		0·59	0·42
Inches	0·0555		12·7	0·0232	
Millimetres	1·00	7·0		0·43	0·43
Inches	0·0394		17·8	0·0169	
Millimetres	0·85	8·0		0·40	0·47
Inches	0·0335		20·3	0·0157	
Millimetres	0·71	9·0		0·40	0·56
Inches	0·0280		22·9	0·0157	
Millimetres	0·59	10·0		0·41	0·69
Inches	0·0232		25·4	0·0161	
Millimetres	0·50	12·0		0·33	0·66
Inches	0·0197		30·5	0·0130	
Millimetres	0·42	14·0		0·29	0·69
Inches	0·0165		35·6	0·0114	
Millimetres	0·36	16·0		0·26	0·72
Inches	0·0142		40·6	0·0102	
Millimetres	0·29	20·0		0·21	0·72
Inches	0·0114		50·8	0·0083	
Millimetres	0·25	23·0		0·185	0·74
Inches	0·0098		58·4	0·0073	
Millimetres	0·21	27·0		0·16	0·76
Inches	0·0083		68·6	0·0063	
Millimetres	0·17	31·0		0·15	0·88
Inches	0·0067		78·7	0·0059	
Millimetres	0·14	39·0		0·116	0·83
Inches	0·0055		99·1	0·0046	
Millimetres	0·125	47·0		0·089	0·71
Inches	0·0049		119·4	0·0035	
Millimetres	0·105	59·0		0·064	0·61
Inches	0·0041		149·9	0·0025	
Millimetres	0·088	67·0		0·061	0·69
Inches	0·0035		170·2	0·0024	
Millimetres	0·074	79·0		0·053	0·72
Inches	0·0029		200·7	0·0021	
Millimetres	0·062	98·0		0·040	0·65
Inches	0·0024		248·9	0·0016	
Millimetres	0·052	110·0		0·039	0·72
Inches	0·0021		279·4	0·0015	
Millimetres	0·044	127·0		0·035	0·80
Inches	0·0017		323·0	0·0014	

The Gopeng Tin Mine.—In the June *Magazine* of the Federated Malay States Chamber of Mines, a short account is given of the Gopeng mine, situated on the eastern side of Kinta valley, Perak. The Gopeng is probably the largest alluvial tin mine in the world, and the proved ground will last a great many years. The company belongs to the group controlled by Mr. James Wickett of Redruth, and the property is managed by Messrs. Osborne & Chappel. It has been the desire of both controller and engineers that an adequate article on the mine should be written for *The Mining Magazine*, but the military duties of part of the staff, and the closer attention to actual mining work required of the other members of the staff, have placed article-writing on one side at present. In the meantime we take pleasure in quoting the short notes in the Malay magazine. Preliminarily it should be said that the Kampar water-supply scheme was undertaken conjointly with the Lahat Mines Limited, a London company.

All ground is cut away by monitors having nozzles 1½ in. to 2 in. in diameter, which deliver water at pressures varying from a minimum of 85 lb. on the old water supplies, to a maximum of 160 lb. on the 45 in. pipe which constitutes the main supply. The ground cut at the lower levels is all elevated by means of 2½ in. jet elevators of standard type. The main water supply is drawn from the Kampar river, which is tapped at a point eight miles from the mine. From here the water is carried in a pipe 45 in. diameter throughout, and designed to deliver 6,000 cubic feet per minute at a working pressure of 150 lb. per square inch. The intake works consist of a concrete dam built across the river bed and founded on solid granite. An overflow 155 ft. long is provided to deal with exceptional floods. The dam is 45 ft. high from foundation to crest of overflow at the highest point, and the average height is 30 ft. Floating logs and pieces of wood are prevented from entering the pipe by suitably placed grizzlies, and the water, before entering the pipe through a bell mouth, 90 in. in diameter, flows through a large concrete settling-chamber where any slime and sand carried over are deposited.

The pipes were constructed by the Mephan Ferguson Lock Bar Pipe Co., Ltd. The plates for the barrel are rolled in two semi-circles and joined by the company's patent lock bar, while the joints between successive lengths of pipe are of the butt variety. The barrels are linked up with a small clearance, ½ in. to 1 in., between each by a butt strap riveted on to each barrel by a single row of rivets. These straps are 6 in. broad and are made in two halves; they lie almost flush with the locking bar, which prevents a complete circling of the barrel by the straps. To complete the joint two cover plates covering both the locking bar and the end of the straps are riveted on. The standard length of pipes is 28 ft. Special expansion joints with tallow-packed glands are placed at distances not exceeding 500 ft. All angles up to 5° are taken up at expansion joints, and angles above this figure are made in special steel castings provided with suitable holding-down bolts. These castings are made to four patterns, 10°, 15°, 20°, and 25°, with expansion joints for connecting up with spigot ends of steel pipe on either side. The bends are bolted down to large blocks of concrete varying from 10 to 80 tons according to the thrust they are subjected to. Air valves are fixed on the summits and scour valves at all depressions; the former are 4 in. diameter of the double aluminium float type, and the latter 10 in. diameter.

The pipe line is all laid above ground and is supported on concrete pillars. These are found on rock, firm earth, or on piling. Usually the spacing of piers is 28 ft. apart, but where the nature of the foundation requires it, the intensity of the load is reduced by spacing the piers 14 ft. apart, also by increasing the area of the footings. Three lattice bridges of 80 ft. and one of 55 ft. span were constructed to carry the pipe line over the Kampar river, while to bridge small ravines and uneven ground 37 lengths of trestling were erected. The latter vary in length from 14 ft. to 322 ft., and in height from 5 ft. to 30 ft. All bridges and trestle work are of steel.

The two old pipe lines put in by the original companies are still in use and draw their supply from the Garuntong river. They carry between them some 1,500 cubic feet per minute, and the water is delivered on the mine at a pressure of 85 lb. per sq. in. The water flows from the headworks through ditch lines five miles long and enters the pipes, which carry the water the remaining distance of 3 to 3½ miles.

The Gopeng property is divided into two main working sections by the Kota Bharu road, the Lallang section on the north and the Serdang section on the south side. In the latter section most of the high level ground appears to have been sluiced away and operations have been carried on in two paddocks from which the ground is elevated by open-type elevators designed by Mr. E. J. Vallentine. There are no closed-type elevators on the mine, though this type is used for sinking purposes and as a stand-by. The general arrangement and procedure at the Serdang mine is quoted: The area to be worked is first of all opened with small, 1½ in., "water lifters" to a depth of 15 ft. and to an area large enough to put in a closed-type, 3 in., elevator. Sinking is then continued until the desired depth is obtained, when a permanent open-type elevator is installed. While sinking operations are going on, the sluice-boxes are erected. It takes 4 to 6 months to sink safely to a depth of 70 ft. Two elevators are put in each paddock, and all elevators have 2½ in. jets at a pressure of 160 to 180 lb., each dealing with 20,000 to 26,000 cubic yards of solid matter per month, lifting to a vertical height of 66 to 75 ft. The upraise pipes are of 12 in. diameter solid-drawn piping, and are erected to a vertical angle of 55° to 65°. They deliver into a "feed palong" 100 to 170 ft. long, having two compartments each 5 ft. wide at a grade of 1 in 45. The feed palong in turn discharges into the main sluice-boxes, which consist of three 7 ft. wide compartments at a grade of 1 in 50 and are from 300 ft. to 400 ft. in length. The washing up of the sluice-boxes is done by Malay dulang women. A 30 in. offset of the main pipe supplies the water on the Serdang side, and the Venturi meters in the distribution station permit a maximum of 2,500 c.f.m. to pass through. The 30 in. main service pipe is over half a mile long and then branches off into two 22 in. lines which in turn give way to pipes 16 in., and 12 in., and 8 in. in diameter. The Lallang section is larger than Serdang section and consists of two paddocks containing five elevators and six ground sluices.

The mines are lighted throughout with electric light. The total yardage washed per month is 190,000 cubic yards. The average recovery value is 0·80 katties per cubic yard. The labour consists of Chinese, Tamils, and Malays. The working costs are 12 cents per cubic yard. The dividend last year was 15%. The monthly output is 1,500 to 1,600 piculs.

Zinc in French Indo-China.—A report by the United States representative at Saigon, recently published by the Consular Service, gives particulars of the zinc-mining industry of French Indo-China. During the past five years the export of zinc ore from Haiphong has averaged nearly 27,000 tons per annum. The value of this ore, as declared for customs purposes, averaged £128,000 per year. Although some zinc ore has been mined in Annam, and though undoubtedly it exists also in the interior Protectorate of Laos, practically all of that now produced in French Indo-China comes from the Protectorate of Tonkin. The zinc mines worked at present occupy a strip about 50 miles wide and 100 miles long just above the delta district, a little north and a little east of the centre of the protectorate. There are four well-defined zinc regions. The oldest is the Tuyen-Quang district, near the town of the same name at the junction of the Clear and Gam rivers. The ore from this group is carried in river steamers down the rivers and through the canals to Haiphong. Next in age, and in recent years the most productive district, is the Thai-Nguyen region, above the town of this name, on the Song Cau, about 50 miles east of Tuyen-Quang. The ore from these mines is floated in sampans down to Dap Cau, nearly 100 miles, then transferred to river steamers. On the extreme east is the Than-Moi or Langsor region, on the upper waters of the Song Thuong, and along the railway between Phulang-thuong and Langsor. The ore from this region is transported by rail to Phu-lang-thuong, where it is loaded on river steamers. The newest and possibly the richest of the regions is the Cho-dien or Bac-kan district, east of the Song Gam, about 50 miles above Tuyen-Quang. The ore from the Cho-dien mines is carried by a private railway to the Song Gam, then by sampans to Tuyen-Quang, whence it is transferred to river steamers. These four regions include about thirty zinc concessions, of which only eleven are at present in process of exploitation.

Although the Chinese are known to have obtained zinc from Tonkin before the French occupation, the serious exploitation of the ore dates from 1906. In this year some coolies working on the estate of Commandant Cadars at Trang-da, opposite Tuyen-Quang, discovered a vein of zinc ore. Further search proved the deposit to be rich. Lacking the necessary capital and experience, M. Cadars formed the Société des Mines de Trang-da, with a capital of 300,000 francs, and with its headquarters at Tuyen-Quang (later changed to 35, Rue de Clichy, Paris), for the development of the first zinc mine of Tonkin. The first year this mine produced about 2,500 tons of ore. In 1909 the production had reached 8,000 tons, and since that date the annual output of this mine has remained at about 10,000 tons. The discovery of zinc at Trang-da led to the exploitation of the old Chinese mines at Lang-hit near Thai-Nguyen. Several mines were developed, and in 1909 M. Marcel Pierron, backed by the German firm of Speidel and Co., formed the Société Minière du Tonkin, with a capital of 1,000,000 francs, with its main office at Haiphong (later transferred to 14, Rue Vézélay, Paris). At that time these mines produced only a few thousand tons of calamine and blende, but in 1911 their production reached 14,432 tons, and they have since held first rank among the zinc mines of Tonkin. In 1909 also the Société Minière de Than-moi was formed at Paris (14, Rue Vézélay) by M. Marcel Pierron, who retained 80% of the stock. Its mines are on the Song-Thuong, between Phul-lang-thuong and Langson. The production of these mines has been irregular, varying from 492 tons in 1911 to 5,368 in 1914, but the ore is of a high grade. In the meantime M. Cadars and others discovered three other veins near Trang-de-Kem, Con-rau, and Con-rong, and in 1910 they organized for their exploitation the Société des Mines de Yenlink, a joint-stock company with a capital of 700,000 francs and with its headquarters at Tuyen-Quang. The output of this group during the first four years averaged only about 1,100 tons per year; but in 1915 its production was about 3,000 tons, and in 1916 about 4,000 or 5,000 tons. Several other concessions have been taken up in the Tuyen-Quang region; but the only other mine that has been sufficiently productive to deserve mention is that of Bac-nhung, belonging to Perrin Frères, which in 1914 produced about 450 tons of ore.

The Van-lang mines in the Thai-Nguyen group began production in 1911, although the concession was not granted until the next year. It is operated by the Société d'Exploitation des Mines de Van-lang, Hanoi. The production of this mine for the years 1912 to 1914 inclusive, was respectively 1,800, 1,500, and 1,672 tons of blende, calamine, and galena. The ore is of low grade, and the mine ceased operations after the outbreak of war. The Cho-dien concessions were granted in 1912, but, because of the inaccessibility of the mines, actual exploitation did not begin until 1914. Here the proprietor, M. G. Bault, Hanoi, was obliged to build a railway of 35 kilometres (about 22 miles) from the mines to the Song Gam at a cost of nearly a million piastres. This railway was not completed until July, 1914. During that year about 1,900 tons was produced, and during 1915 the production reached 8,600 tons. At present the Cho-dien mines are surpassing all others, and a yield of 15,000 tons was expected for 1916. The ore is mined in the open from the side of a hill, and it is said that 80,000 tons of 52% ore is exposed. This seems to be the future zinc district of Tonkin.

The grade, and sometimes the character, of the zinc ores of Tonkin vary with the different mines, and even in the same mine. The most common ores are blende and calamine. These ores range from 40 to 55% metallic zinc. The accompanying table gives details of ore produced in 1914.

Mine.	Character of ore.	Metallic Content. Per Cent.
Trang-da	Calamine	40
Kem	Calamine	45
Bac-nhung	Calamine	52
Lang-hit	Calamine and blende	50
Van-lang	Calamine blende and galena	45
Than-moi	Calamine and blende	56
Cho-dien	Calamine	50

Zinc Metallurgy.—The October meeting of the American Institute of Mining Engineers is being held at St. Louis, the centre of the Missouri-Kansas, or Joplin, lead-zinc district. Appropriately the papers presented deal preponderatingly with zinc metallurgy. George C. Stone, chief metallurgist to the New Jersey Zinc Co., describes the application of the old Burrows-Wetherill process for making zinc oxide direct from franklinite at the Palmerton works, Pennsylvania, and W. R. Ingalls discusses this process in its relation to the metallurgical treatment of complex ores. W. G. Waring describes the composition, character, and variation of the zinc ores of the Joplin district. L. A. Delano gives the concentration practice at the St. Joseph Lead Co.'s mines. Other papers were on Economic Factors in the Production of Electrolytic Zinc, by R. G. Hall, and Zinc Dust as a Precipitant in the Cyanide Process, by W. J. Sharwood. These papers are printed in the September *Bulletin* of the Institute.

Bunker Hill Metallurgy. — In the *Mining and Scientific Press* for August 25, C. L. Larson describes methods adopted by the Bunker Hill and Sullivan company for treating lead ores by chloridizing roasting and leaching with common salt solutions.

Smelting at Kalata.—In the *Mining and Scientific Press* for September 1, F. W. Draper describes the smelting of copper ores at Kalata, in the Ural Mountains, Russia, conducted by the Verk Isetz Corporation.

Copper Refining.—Lawrence Addicks, in *Metallurgical and Chemical Engineering* for August 15, writes on the recovery of by-products in electrolytic copper refining.

Tin Assays.—The *South African Mining Journal* for August 25 contains an article by Alfred Adair giving new ways for estimating tin in low-grade material. We intend to quote this paper in our next issue.

Gold Production.—The *Engineering and Mining Journal* for September 8 publishes its estimate of gold production throughout the world during 1916, making the total $470,442,068, as compared with $478,552,222 in 1915, and $460,097,428 in 1914.

The Cresson Gold Mine.—In the *Mining and Scientific Press* for September 15, Horace B. Patton gives a geological description of the bonanza ore at the Cresson mine, Colorado, discovered in 1914.

Flotation Machines.—In the *Mining and Scientific Press* for August 11, B. M. Snyder describes the machine erected by George Crerar for concentration of flotation in Montana and Nevada, being a variation of the Callow aeration method.

Flotation.—In the *Mining and Scientific Press* for August 25, T. A. Rickard writes on the flotation of gold and silver mineral.

Flotation.—In the *Mining and Scientific Press* for September 15, James G. Parmelee writes on the cyaniding of flotation concentrate.

Dredging Practice. — The *Engineering and Mining Journal* for September 1 prints the proposed safety rules for gold-dredges issued by the California Accident Commission.

Timbering in Alluvial Mining.—In the *Mining and Scientific Press* for August 11, H. T. Power describes the drifting in deep alluvial mining, with methods of timbering, at the Hidden Treasure mines, Placer county, California.

Signalling in Mines.—*The Iron and Coal Trades Review* for September 28 prints a paper by R. W. Hall, read before the North of England branch of the National Association of Colliery Managers, describing the operation of the Pearce-Hall signal indicator for shaft-signalling in mines.

South Rand Goldfield.—At the September meeting of the North Staffordshire Institute of Mining Engineers, A. R. Sawyer read a paper on the South Rand goldfield, dealing with his bore-hole investigations of the South Rand Goldfield Corporation conducted before the Boer war.

Briquetting Iron Ores.—At the September meeting of the Iron and Steel Institute, G. Barrett and T. B. Rogerson read a paper reviewing the present practice in the briquetting of iron ores.

Coal Briquetting.—At a meeting of the South Wales Institute of Engineers held on September 25, J. A. Yeadon read a paper on the briquetting of anthracite.

Iron Ore Resources.—The *Journal* of the Royal Society of Arts for September 28 commences the publication of a series of lectures by Professor W. G. Fearnsides on the Shortage of the Supply of Non-Phosphoric Iron Ore in this country.

Silica Brick.—*Metallurgical and Chemical Engineering* for August 15 reprints papers on silica brick presented at the meeting of the American Society for Testing Materials.

Molybdenite.—The *Queensland Government Mining Journal* for July contains a description of molybdenite mines at Khartoum, near Almaden, North Queensland, by E. C. Saint-Smith.

Molybdenite.—In the *Engineering and Mining Journal* for August 25, Sydney H. Ball gives a general account of molybdenite, its occurrences, and uses.

Graphite.—In the *Mining and Scientific Press* for September 15, L. W. Brooks writes on the production and uses of graphite.

Phosphate Deposits of Idaho.—R. N. Bell, State Inspector of Mines, writes briefly on the enormous reserves of rock phosphate in Idaho in the *Engineering and Mining Journal* for August 18.

Manganese Ores.—A paper by E. C. Harder, contained in the September *Bulletin* of the American Institute of Mining Engineers, describes the manganiferous iron ores of the Cuyuna iron district, Minnesota.

Boleo Copper.—In the *Engineering and Mining Journal* for September 8, Lindsay Duncan gives some particulars of operations at the copper mines of the Compagnie du Boleo, in Lower California.

RECENT PATENTS PUBLISHED.

10,879 of 1914 and 9,127 and 9,128 of 1917 (109,036-7). A. G. WILHELM GRILLO and W. SCHEFEZCH, Hamborn, Germany. Roasting furnaces for zinc ores.

24,646 of 1914. R. SAMESREUTHER and AUTOGEN SIRIUS, Düsseldorf, Germany. Method of welding nickel and nickel alloys.

7,260 of 1915. C. BEINDL, Munich, Germany. Catalytic method of producing hydrocyanic acid.

5,174 of 1916 (105,571), and 7,661 of 1916 (100,681). H. B. HOVLAND, Duluth, U.S.A. Apparatus for treating ores under pressure and producing floatable sulphide.

6,702 and 14,467 of 1916 (108,688). F. E. STUDT, London. Electrolytic process for precipitation of copper from solutions, introducing sulphurous acid gas to prevent precipitation of iron.

6,935 of 1916 (108,692). T. BOBERG AND TECHNO-CHEMICAL LABORATORIES LTD., London. Method of making sodium ferrocyanide.

7,601 of 1916 (100,545). H. B. HOVLAND, Duluth, U.S.A. Apparatus for treating ores under pressure.

11,186 of 1916 (106,460). DEUTSCHE GOLD UND SILBER SCHEIDE ANSTALT, Frankfurt, Germany. Manufacture of perborates.

11,143 of 1916 (108,363). F. THARALDSEN, Christiania, Norway. Improvements in electric furnaces for smelting zinc ores.

11,203 of 1916 (101,215). J. G. AARTS, Breda, Holland. Improvements in vertical retorts for coking or metallurgical reduction, having for their object the greater heat insulation of the walls.

11,963 of 1916 (108,735). C. A. ROWE, Liverpool. Method of making red lead and orange lead.

12,873 of 1916 (108,755), and 13,259 and 13,614 of 1916 (108,920). E. A. ASHCROFT, London. Making anhydrous magnesium chloride by reacting with gaseous chlorine on magnesia, or magnesium carbonate.

12,878 of 1916 (108,918). R. L. DATTA, Calcutta. Producing iodine by the action of oxides of nitrogen on hydriodic acid.

15,800 of 1916 (108,782). G. KERMODE, London, and A. R. MILLER, Birmingham. Furnace for refining zinc.

1,099 of 1917 (108,808). W. FELDENHEIMER, London. Method of purifying china-clay.

8,160 of 1917 (107,019). GOLD UND SILBER SCHEIDE ANSTALT, Frankfurt, Germany. Extracting borax from mixtures containing boric acid or borax and sodium sulphate.

NEW BOOKS

Introduction to the Rarer Elements. By P. E. Browning. Fourth edition. Cloth, octavo, 260 pages. Price 7s. net. New York: John Wiley & Son; London: Chapman & Hall.

In recent years many of the rarer elements have found increasing applications of technical importance. Tantalum, tungsten, and osmium, and to a less extent compounds of thorium and zirconium have been extensively employed for the manufacture of filaments for electric lamps. The oxides of cerium and the other rare earths are used for colouring glass, and those of uranium and vanadium have similar applications in the glass and ceramic industries, while for special decorative purposes titanium and molybdenum oxides and even iridium are also utilized. Thorium nitrate has acquired great importance in the manufacture of incandescent gas mantles. Titanium in the form of ferro-titanium greatly increases the tensile strength and life of steel, and tungsten is now used for high-speed steel. Selenium conducts electricity when under the influence of light, and has therefore made possible the transmission of photographs by telegraph. Many other comparatively rare substances are used for chemical purposes, in photography, and in medicine. Thus, on the one hand the applications of industry have been responsible for a great advance in our knowledge of the rarer elements, while on the other they have stimulated the search for mineral deposits from which they may profitably be extracted.

In Dr. Browning's book, already well known, but now thoroughly revised and increased in size and scope, the chemistry of the rarer elements is gathered together in a convenient form. For students there is a useful course of experimental work, while for professional chemists and metallurgists the references to literature and particular problems and applications give the book a technical value. In each chapter a list of the chief minerals in which the element or group of elements concerned is found, is given with their chemical composition. Each element is dealt with on a more or less uniform plan. Titanium for example is considered under the following headings, which serve to illustrate the general scope of the book: discovery, occurrence, extraction (from minerals), preparation and properties of the element, compounds and their characteristics, estimation, separation, experimental work. Special attention has been given to spectroscopy, and there are several spectroscopic charts and tables. The chapter on the radioactive elements has been revised by Prof. Boltwood, by whom it was originally contributed.

ARTHUR HOLMES.

Asphyxiation from Blast-Furnace Gas. By Frederick H. Willcox. Pamphlet, 70 pages, illustrated. Washington: Bureau of Mines.

This is a useful guide to the dangers of carbon monoxide, and it should be in the hands of everybody connected with not only blast-furnaces, but with gas-producers and furnaces using gaseous fuel. It is issued by the United States Bureau of Mines in pursuance of the endeavour to increase safety and efficiency in metallurgical industries. It discusses the nature and causes of poisoning from blast-furnace gas, itemizes the places where gas may be expected to be encountered, suggests safeguards, and points out the precautions to be taken in working near gaseous places. Blast-furnace gas is peculiar in that it is very poisonous, and under certain conditions, as when it has been cleaned, it is without colour or odour by which it may be detected. Gas is practically always present about the top and bottom of the furnaces, frequently in such small proportion that it is not evident to the physical senses, but at the same time in sufficient volume to cause asphyxiation if breathed for 20 or 30 minutes. Proportions sufficient to cause asphyxiation or gassing also occur with more or less frequency all along the route of the gas, at the stoves and boilers when they are taken off for cleaning or repairs, inside of gas mains, downcomers, and other parts of the gas-main system, at sand or goggle valves, and during repairs to the charging equipment and stock line. The increasing application of furnace gas to gas-driven blowers and generators has introduced additional equipment such as tower washers, fans, and other cleaning devices that also must be entered from time to time for cleaning and repairs. At all the above places there is always the possibility that gas may be present where the crews have to work, either from leakage, insufficient ventilation, or from emission of gas retained in the brickwork, flue dust, or deposits in the apparatus. Though poisoning by blast-furnace gas usually results in nothing more serious than illness and severe headache, it may cause unconsciousness and even death. Realization of the dangers and a strict observance of every precaution is essential in undertaking any work in an atmosphere contaminated by furnace gas, or in sending men into confined places in proximity to material emitting gas or difficult to ventilate.

A Short Account of Explosives. By Arthur Marshall. Cloth, quarto, 100 pages, illustrated. Price 5s. net. London: J. & A. Churchill.

We have on several occasions referred to Mr. Marshall's compendious book on explosives. We have now to welcome a smaller book from his pen. It may be taken as a guide to the study of his big book, or at least a preparatory treatise paving the way to its intelligent study. A great many engineers nowadays are having to pay attention to explosives, a subject on which their previous knowledge and experience have been practically nil. This book meets their requirements excellently. For this reason, and also owing to its low price, it should have a large sale.

The Canadian Mining Manual, 1916-7. Edited by Reginald E. Hore. Cloth, octavo, 450 pages, with many illustrations. Price 12s. 6d. net. Toronto: *The Canadian Mining Journal*.

The present issue of this year-book fully maintains the high standard set by the founder, the late B. T. A. Bell. The volume begins with a general review of the progress of the Canadian mining industry, with recent statistics of output and production. Then follows a lengthy section, occupying one-third of the book, devoted to each mineral and metal individually. Details are next given of notable discoveries of new deposits. The remainder of the book, 220 pages, is devoted to a directory of the various mining companies operating in Canada, with their capitalization, constitution, nature of business, etc., with some technical details of the work done. The maps and photographic views are of considerable assistance, and the portrait gallery of mining engineers adds an interesting human touch.

Reports of the Progress of Applied Chemistry. Vol. I, 1916. Cloth, octavo, 340 pages. Price 5s. net. London: The Society of Chemical Industry.

For some years the Chemical Society has issued year-books reviewing progress in discoveries in pure science and analysis. Now the Society of Chemical Industry has followed suit with a similar publication devoted to industrial chemistry. The first volume has just made its appearance. It deals with Fuel, Gas and Tar Products of Distillation, Mineral Oils, Colouring Mat ters, Pigments and Varnishes, India-Rubber, Glue, Glass and Ceramics, and various other subjects. The sections on metallurgy and electro-chemistry, among others, will appear in a supplementary volume. Each of these subjects is handled by acknowledged experts, who are able to judge of the value and application of the various new steps or proposals. In this way the volume supplements the fortnightly *Journal* of the Society, which contains short non-committal abstracts of articles and papers as they appear,

Elements of Coal Mining. By Daniel Burns. Cloth, octavo, 240 pages, illustrated; price 3s. 6d. net. London: Edward Arnold.

The author is professor of mining in the Royal Technical College, Glasgow, and has written this elementary book for the benefit of young men training for superior places among coal miners.

Prospects of Finding Oil in the Southern Karroo. In this pamphlet, issued by the Geological Survey of South Africa, Dr. A. W. Rogers reviews the evidence favouring the hope of finding oil in the Southern Karroo.

Insizwa Mining Areas. The South African Geological Survey has issued Sheet 27 of the geological map of the Cape Province, covering part of the Insizwa district, with an explanatory pamphlet by A. L. Du Toit. This region contains the nickel-copper deposits described recently by W. H. Goodchild.

COMPANY REPORTS

Renong Dredging. — This company was formed in 1908 to acquire alluvial tin deposits on the Renong and Pakchan rivers in the western states of Siam. The properties were examined by E. T. McCarthy, who is a member of the board. Dredging commenced in 1910, and two other dredges were added subsequently. The operations have been ably conducted, and the profits have been good, with the exception that during the year 1915-16 unusual stoppages, caused by necessary repairs, resulted in a loss on the year's work. The report for the year ended June 30 last shows that these temporary troubles have been removed, though further necessary repairs to No. 1 dredge made the loss of time greater than the average to be expected. The total gravel treated by the three dredges was 2,170,177 cu. yd., and the yield of tin concentrate 970 tons, or almost exactly 1 lb. per yard. The sale of concentrate brought an income of £120,189, or 13¼d. per yard. The cost, including depreciation £11,231, was £81,206, or 9d. per yard, leaving a profit of £38,983, or 4¼d. per yard. Out of the profit, £3,750 was paid on the preference shares, being at the rate of 15%, and £26,180 on the ordinary shares, at the rate of 30%.

Lisburne Development.—This company was formed in 1907 to develop the Glogfawr group of lead mines at Pontrhydygroes, Cardigan, Central Wales. R. R. Nancarrow is manager. Unfortunately the lodes are small and patchy, and it is difficult to make a profit. The report for the year ended June 30 last shows that 7,723 tons of ore was raised and milled, for a yield of 380 tons of lead concentrate. This brought a profit of £1,410, of which £584 was allowed for depreciation and £211 was paid as income tax. The 10% preference shares received their dividend, absorbing £400, and £314 has been paid on the ordinary shares, being at the rate of 2½%. During the year the outstanding debentures, £1,100, were redeemed. Developments during the year have not maintained the reserve. The labour question has caused trouble, for many men have gone to timber-felling, at which much higher wages can be earned. The men that remained agitated for an increase in their rate of pay, and it has been necessary to advance the wages by 50 per cent

Grenville United Mines.—This company was formed under limited liability in 1906 to acquire a tin mine south of Camborne, Cornwall, that had previously been worked for many years on the cost-book plan. Satisfactory profits were made during the first few years, but since then the steady decline in the tin content of the ore has led to losses. The report for the six months ended June 30 last shows that the position is becoming worse. The amount of ore treated was 21,013 tons, and the yield of tin concentrate 214 tons, being an extraction of 22·83 lb. per ton. The receipts from the sale of concentrate were £24,404, and the loss on the period's operations £10,046. During the previous half-year, the output was 260 tons and the yield per ton of ore 26¾ lb. Four years ago the half-year's output was 349 tons, and the yield per ton 37 lb. The losses of the last year or so have made serious inroads into the financial resources of the company. The report of Henry Battens, the manager, shows that developments are being pushed, but it does not appear that there is any improvement in the grade of the ore disclosed.

Broken Hill Block 10.—The mine belonging to this company was closed on the outbreak of war, as the lead concentrate was sold to Germany. It was reopened in May 1916, on the conclusion of a contract for the sale of the lead concentrate to the Associated Smelters Proprietary, of Port Pirie. The zinc tailing is still sold to the Amalgamated Zinc (De Bavay's). The report for the half-year to March 31 shows satisfactory results, though shortage of labour prevents the operations being conducted at full capacity. The ore raised was 37,258 tons averaging 12·4% lead, 13·3% zinc, and 10·9 oz. silver per ton. The output of lead concentrate was 5,741 tons averaging 61·1% lead, 7·9% zinc, and 36 oz. silver. The tailing averaged 14·3% zinc, 3·5% lead, and 6·3 oz. silver. The accounts show an income of £76,566, and a profit of £21,136, out of which £10,000 was distributed as dividend, being 2s. per £10 share. Development on the 515 ft. level has passed through a lode near the boundary of the Sulphide Corporation that was previously worked by the latter company. The lode is strong and the assays average 12% lead, 8·3% zinc, and 3·9 oz. silver. Arrangements have been made, as recorded in the previous half-yearly report, with Block 14 to treat some of the latter's ore, and flotation plant is being erected for working ore from both mines on a mutual basis. We have already, in our February issue, given particulars of the company's gold-mining venture on Misima Island, off the eastern extremity of New Guinea.

Broken Hill Block 14.—For some years this company has subsisted by reclamation of carbonate lead-silver ores from the upper levels. The report for the half-year ended March 31 shows that 3,189 tons of carbonate ore, averaging 23·88% of lead and 11·56 oz. silver, was raised, and sold to the Port Pirie smelters. The accounts show an income of £18,675, and a net profit of £2,329. By drawing on the balance in hand it was possible to pay dividends at the rate of 5% for the half year on the 100,000 preference shares of 6s. each, absorbing £1,500, and £5,000 on the preference and ordinary shares, the latter being of 25s. each, the rate being 6d. per share. As mentioned in our paragraph relating to Block 10, arrangements have been made for a joint concentration plant, Block 14 to supply 1,000 tons of ore per week. The company has exercised its option on 40,000 shares in the King Island Scheelite Company. The plant required at this mine has been delivered, and production of concentrate was expected to start in September.

NIGERIAN TIN CORPORATION, LIMITED.

Directors: Oliver Wethered (*Chairman*), Richard Arnold, Herbert J. Moir, C. V. Thomas. *Secretary:* George Kerr. *Office:* Capel House, New Broad Street, London, E.C.2. *Formed* 1909. *Capital issued:* £79,567 in £1 shares.

Business: The development of alluvial tin deposits in Nigeria; holds interests in a number of operating companies in Nigeria, notably the Rayfield and N. N. Bauchi, and in Cornwall and the Malay.

THE ordinary general meeting of the Nigerian Tin Corporation, Ltd., was held on September 20 at Winchester House, London, E.C., Mr. Oliver Wethered (Chairman of the company) presiding.

The Secretary (Mr. George Kerr, A.C.I.S.) having read the notice convening the meeting and the report of the auditors,

The Chairman said: Gentlemen,—I am very sorry that the meeting is being held so late in the year, but the delay is due to several causes, all of which were quite beyond our control. Depleted staffs, both here and in Nigeria, longer intervals between the despatch of mails, some of which have been lost, and the heavy pressure on auditing staffs have contributed to the delay, but I am glad to tell you that the period which has elapsed since the date of the accounts has enabled us to focus our position more accurately and to report a most gratifying improvement in the general position. Dealing first with the accounts, there has been no change in the capital issued, which remains at £79,567, and the premiums received on shares, equivalent to nearly 40% on the issued capital, remain practically as before. The outstanding calls have been reduced to £87. The item of sundry creditors—namely, £20,476 5s. 2d.—was principally in respect of advances on tin, freight, insurance, etc. Against this we had tin in transit, but the position to-day has much improved, the liability in this respect being about £14,000, which should be covered by tin on hand and in transit. Turning to the other side of the balance sheet, you will see that shares in other companies stand at £67,919, this being the book value. In this connection the certificate of the auditors states: "It is not possible to verify the value of the company's investments as a whole, but the market value of such shares as are quoted is considerably less than the book value." That was the position at December 31 last, and it was perfectly right the auditors' certificate should contain that clause, but to-day the market value is over £80,000 and there are actual quotations in the financial press for some £68,000 of this amount. In addition, and not included in these figures, we hold shares of great prospective value in regard to which for the time being no valuation is obtainable. The next item I will refer to is the loans and interest. I am glad to state that this item of £27,384. 16s. 2d. has been reduced since the date of the balance sheet by no less than £24,500. Now against the items of £67,919 and the balance of loans still outstanding, amounting now to only £2,884, in all £70,803, we have the reserve against depreciation or loss in this respect of £35,678, being over 50% of the book value of the items in question. The sum advanced to Nigerian Stannaries, Ltd., is being gradually reduced by the proceeds of tin realized from that company's property.

Turning to the profit and loss account, there is not much requiring comment. The amount spent on prospecting and development and all other Nigerian expenditure has been written off, including, of course, the lease rents and license fees, amounting to £1,536 10s., which item should be materially less in future owing to the new regulations. With regard to the London expenditure, I would remind you that it is in respect of a period of eighteen months and that the working of the business of a finance and mining company involves far more work and expense than is the case in a purely mining company. The dividends and interest and net profits on the sale of investments were only £3,098. 1s. 5d., but that any profit could be made in such times of difficulty by the realization of shares indicates the increasing interest now being shown by the public in investments in the shares of tin producing undertakings.

I am sorry that I am not in a position to tell you as much with regard to our properties as I could wish but I would again remind you of a circular issued to the shareholders on May 3 last, wherein the opinion of the manager, Mr. Hancock, was given to the following effect, namely, that the new areas referred to in the report are of greater value than those surrendered and should yield a higher average output than has been obtained in the past. These new areas are being prospected, but at a time when there is great scarcity of labour, and unfortunately of food also. In the course of the next few weeks Mr. Hancock, the manager in Nigeria, who has had some six years' experience of the country, hopes to return to England, and he will then be able to give us more information with regard to these properties and some new areas taken up since December 31 last in a very productive part of the field. His letters dealing with these new properties have unfortunately been lost, but the cabled information regarding them is extremely interesting.

I notice that one or two newspapers refer to the fact that we do not give a schedule of our investments. Now, this is a point that has been discussed at a good many meetings of finance companies, and I unhesitatingly say that it would be very detrimental to the interest of the shareholders to state specifically the numbers of any particular holding; but I will briefly refer to some of our largest interests. We hold a very large number of shares in the Rayfield (Nigeria) Tin Fields, Ltd., and are, in fact, the largest shareholders. The developments on that company's properties, and its acquisitions during the last twelve months, have most materially enhanced the value of its assets. As I am chairman and managing director of that company, I can speak with every confidence on this point. We are also among the largest, if not the largest, shareholders in the Northern Nigeria (Bauchi) Tin Mines, Ltd. The reports published by this company from time to time regarding their developments show that they are increasing their reserves at a very rapid rate. Similar discoveries to that on the Rayfield (Nigeria) property have been made here, and it is certain that the large areas of unexplored ground on both properties will show the existence of other important deep deposits. In passing, I may mention that that is one of the most interesting features in Nigeria. In the early days all that one could see was the rivers, and as work went on they found the tin deposits extended into the banks; but we are now getting very rich tin of very high quality at depths down in one case to 104 ft. It is true that there is a good deal of overburden which has to be removed, and this is done in most cases by sluicing in the wet season; but when we again get into normal times there is no doubt mechanical appliances will be used to take off some of the heavy overburden, and then these deposits which companies like Rayfield and Bauchi are opening up will make very large and permanent yields. Among other Nigerian shares, we are interested in Jantars, Gurums, Central Lafons, and several other companies, and, speaking generally, the outlook is good, and in the case of the first two most satisfactory. Jantar recently paid 2s. 6d. per share dividend, and before long will make a similar distribution.

As you are aware, we have also taken important interests in Cornwall. We were considerable shareholders in the East Pool company, and only realized this very valuable holding when it showed a profit of nearly 200%. The developments on that property have created a mild sensation in Cornwall, but in America or elsewhere I do not hesitate to say the effect would have been much greater. We still hold—and, in fact, have increased—our large interest in the Rayfield (Cornwall) Tin Syndicate, which undertaking suffered very severely in the early days of the war, but the assets of which are daily improving in intrinsic value. That company holds nearly 75% of one property on which between 80,000 and 100,000 tons of highly payable ore have been developed. From the experience of 22 years in Cornwall, I think I may say that that is the most rapid development I have seen, and it may interest you to know that the name of the property is Porkellis. We opened two parallel lines with excellent results, and now that the diamond drilling, to which possibly you have seen reference made in the papers, has been completed at Geevor the plant is this week being moved to Porkellis. We are putting bore-holes in to the north and confidently expect to find two if not three more lodes, which we shall get at a depth from the surface of from 400 ft. to 500 ft. by means of these diamond drills. I may say that the diamond drilling in Cornwall is one of the most important things that has taken place, and it is only due, I think, to Messrs. Bewick, Moreing and Co., who inaugurated that system recently, that diamond drilling has really been seriously entertained. Some 15 years ago we at Dolcoath did a certain amount of drilling, but the machine was not then what it is to-day. At Dolcoath, East Pool, and Geevor, and in connection with other companies we are interested in, diamond drilling is going on, and as a result thereof I look for a very marked and permanent effect on the production of tin in Cornwall. Hitherto it has been the custom to sink down on the ore-bodies in Cornwall, with ever increasing cost for winding and pumping, and increasing water; to-day the practice is lateral development, and, as I say, it is going to have a very important effect on mining in Cornwall, as my friend Mr. Thomas, who is connected with a great many undertakings will, I think, bear me out. Through the Rayfield (Cornwall) we are also interested in the Geevor Tin Mines, Ltd., in Cornwall, and we have, apart from that, an important interest through our direct holding in Geevor shares and also through our considerable holding in the W.A.G. Assets Company, Ltd., which owns nearly one-half of the capital of the Geevor mine.

With your permission I would like to say one word with regard to the position of tin generally. The present price of tin may seem abnormally high to many, but, compared with the pre-war and present prices of other base metals, the appreciation in price is relatively small. The course of prices after the war is the subject of much debate among those interested in the tin industry, but although there seems to be some difference of opinion as to what may happen in four or five years, there is a very general view that the demands for domestic purposes after peace will be very great, and so, I think, we may confidently look for higher prices for some years to some. Personally I am very glad that our interests extend to Cornwall as well as Nigeria. With regard to Nigeria, the alluvial deposits are far more extensive than was deemed possible in the early days of the field, and the newly discovered deep deposits to which I have referred promise a prolongation of life of many years. But all alluvial deposits must ultimately be exhausted, whereas well-selected lode mines have a much longer life. In applying, therefore, as we have done, a certain amount of our resources to lode mines in Cornwall we are confident that we are laying the foundation of a permanency which is not perhaps obtainable from purely alluvial mining. That, gentlemen, gives you the position, but I would like to tell you that as the result of the very much better position, and I am pleased to say the rapidly improving position, we have decided to pay an interim dividend of 1s. per share on the 15th of next month. Those of you who were shareholders in the early days of the company will remember that at one time we paid substantial dividends—in fact, I think we have paid something like 42%—but during the past three or four years it has been utterly impossible, and I would have you believe that this improved position has been the result of the arduous labour, involving very considerable work, of your directors. With these remarks I beg to move that the report and statement of accounts be received and adopted. I will ask my friend Mr. Thomas to second the resolution.

Mr. C. V. Thomas: I have much pleasure in seconding the resolution which the Chairman has moved. I do not disguise from you the fact that I, in common with many others, viewed the position of the company at one time, in connection with certain items on both sides of the balance sheet, with no little measure of anxiety, and I am not foolish enough to ignore some criticisms that have been made by some persons respecting this company and its state of affairs for the last two or three years, but they have been most abnormal and difficult times for a company such as this. The cause of anxiety was due to special reasons rather than the general abnormal causes affecting practically all companies other than those making money out of the war, but I am glad to be able to corroborate the Chairman in stating that this company has emerged completely out of those depths and that the future of the company now bids fair to be a success. At all events, it will not be trammelled from now onward by that burden of difficulty which confronted us until a recent period. I would like to say how much we appreciate what the Chairman has done, and how much the company is indebted to him for the continuous, anxious, and plucky manner in which he has worked for the company and succeeded in pulling it out of the depth into which it had sunk.

The Chairman having replied to several questions, the resolution was put to the meeting and carried unanimously.

KWALL TIN FIELDS OF NIGERIA, LIMITED.

Directors: E. H. L. Eldridge (*Chairman*), C. J. Gibson, H. G. Latilla, J. P. Rowe. *Mine Manager:* R. Cousin. *Secretary:* S. Staveley Briggs. *Office:* 10–11 Broad Street Avenue, London, E.C.2. *Formed* 1912. *Capital issued:* 166,000 shares of 5s. each.

Business: Development of alluvial tin ground about 12 miles west of Bukeru, Nigeria.

10 & 11, Broad Street Avenue,
London, E.C.2,
September 27, 1917.

TO THE SHAREHOLDERS.

Dear Sir, (or Madam),

In forwarding the enclosed report upon the company's properties, dated August 1, made by Mr. John M. Iles (the recently appointed advisory engineer), my directors instruct me to state that they consider this fully confirms previous satisfactory expert opinions as to the prospective value of the company's areas. Mr. Iles explains the reason for the decision to defer the winning of tin during the currency of the present wet season, namely, that advantage be taken of the rains to devote all labour in pushing on with the work of sluicing off the overburden (which in some places is 15 ft. deep), and so reaping the benefit in the dry season which should start during the month of October.

Yours faithfully,
S. Staveley Briggs,
Secretary.

Naraguta,
Northern Nigeria,
August 1, 1917.

To the Chairman and Directors,
Kwall Tin Fields of Nigeria, Limited,
10 & 11, Broad Street Avenue,
London, E.C.

Gentlemen,

I have visited and inspected your Kwall Company's property and herewith have pleasure in submitting for your consideration the following report thereon. I do not think it will serve any purpose my going into details regarding location, distances, etc., as doubtless these matters have been previously placed before you in the different reports which are already in your possession. Also I take it you are chiefly concerned with the value of your property, so I will proceed to deal with this as briefly as circumstances will allow, and in doing so wish you to clearly understand that it is a very difficult problem to arrive at any figures of tonnage of available tin contained in your areas owing to the fact that even in the parts where operations are now being carried on there is not sufficient prospecting done, as beyond the present faces there are only a very limited number of pits sunk. However, I fully recognize that it is at least necessary to give you some approximate idea of the future of your property, as by giving you say the output for any one year does not convey much of a permanent nature, therefore I will endeavour to give you the probable amount of recoverable tin which you may expect from such places as are already producing and in preparation for the same, and in arriving at my estimates I have taken for my guidance the amount of tin won from the paddocks already worked, also pits, tribute workings, etc., and while the latter prove payable tin to exist they do not give any proof of its extent.

Mines.

Ouree and Ahoo Rivers on Plateau.—These two rivers course through your property and upon both operations are being carried on, but at this season of the year very little tin can be won, the ground being some 20 ft. in depth. The best method of working these areas is the one which is being adopted, namely, stripping off the overburden during the rains and in the dry season taking up the tin-bearing dirt from the bottom of the paddock and passing it through sluice-boxes. The main characteristics are practically the same on both rivers, showing sections of workable stream bed and a series of small flats which are not, in my opinion, sufficiently extensive to justify the installation of a plant whereby regular outputs could be maintained during the wet season. Apart from the above there are at different points small patches of terrace ground which will yield a little tin, but there is nothing at present to indicate that they will prove of any extent.

Approximation of 70% Concentrates in Sight.

Ouree River	119 tons.
Ahoo River	400 „

In both these places if there were sufficient pipes on hand the work of sluicing off the overburden could be done very economically, especially on the Ouree river where your manager and I took some levels, with the result that 42 ft. of fall could be obtained with a race 3,000 ft. in length. This would give sufficient pressure with an ordinary nozzle to allow of two labourers removing more dirt than one hundred under present circumstanes, as the ground falls very easily.

Leases off the Plateau.

Danshandon.—This area is situated at the base of the plateau and covers the N'Gel river for a length of 10,300 ft. and, in my opinion, it is here, and in the vicinity that the future of your company lies. The main features of this area are the extensive flats along the stream valley; the most promising occurs at the base of the plateau and as a paddock has been already worked and stripping being proceeded with, also several pits and bores sunk, its contents are, to some extent, measurable. So taking the values given me as correct, and I have no reason to believe they are otherwise, I should estimate that you have at least 400 tons of 70% tin concentrate in this portion of your property. From here down steam the river is crossed at intervals by dykes, or bars, with intervening small flats, and at one point, about one mile distant, sluicing is being carried on, and while the value of the wash dirt is fairly good there does not appear to be any great extent just here. Below this point, a further half-mile on a flat on the left bank of the river a paddock was taken out during last year with, I believe, good results, but at the time of my visit there was too much water and no pumps on hand to do any further work. Lower down the river the main flat crosses to the right bank and the same appears to be of large extent, in fact, I was informed that it is of equal area and value to the flat at the base of the plateau and which I estimated to contain 400 tons of tin. Unfortunately, the river was in flood so I was not able to cross to inspect it. From this point continuing down stream there appears to be long reaches of water held up by rocky bars, which would lead one to believe that between these bars there should be deposits of tin-bearing dirt of more or less extent.

Cameroon Lease. — This lease is close to the Danshandon area and covers a section of the plateau escarpment from the base to the summit upon which there is a detrital deposit over a considerable area. There are a number of scattered tributers' workings to be seen. The depth appears to vary between 6 in. and 2 ft., the tin is very coarse and of excellent quality. Below this deposit there are extensive flats, and in the little ravines payable tin has been obtained by tributers. If the water scheme which I will allude to later on in this report be brought in, I think a lot of tin will be obtained from here, though with the little prospecting done it is most difficult and indeed unfair to the property to even suggest a value and the only alternative left me is to place it at 100 tons. At the same time I am of opinion it will be very much in excess of this, but until it is properly prospected one cannot tell.

Outside the above lease you have large, promising-looking flats at the base of the plateau on the Ouree and Ahoo streams, in fact preparations have been made to wash off the overburden on the former, where I was informed good values were obtained in the pits sunk, but as there are no records of the values and the flood waters had filled in the pits there was nothing to guide me in attempting estimates.

Water.—Your property below the plateau is splendidly situated for economical working as any pressure required could be obtained. It is only a question of first expenditure, for once the water race and pipes were fixed little or no hand labour would be required as the elevating and breaking the ground would be accomplished by water alone, thus exceedingly low values would be profitable. The Kwall Falls would, of course, be the easiest and cheapest scheme to obtain pressure from, but unfortunately another company is making arrangements for a plant to generate electric power to be utilized above the plateau, and as their power station is at its base the water, after passing this, would be too low for us to obtain any benefit in the way of pressure. I do not, of course, know if this scheme will go through, so we are paying attention to an alternative scheme, namely, conveying water from the Ouree river which starts to fall over the plateau at about the same altitude as the N'Gel river. The Ouree is inside your own property and is a fairly large stream. Your manager, and others, inform me that at the driest period of the year, about eight sluice-heads of water pass over it; this, I take it, would be roughly 64,000 gallons per hour. I am not yet prepared to go into figures as to the cost of obtaining the pressure required, as I do not know the distance of the race or the footage of pipes required, but Mr. Cousin has promised me that as soon as his surveyor returns from his short holiday, which he is badly in need of, he will have all levels taken and the line cleared. When this is done I shall be able to give you my estimates as to its total cost, and the amount of plant required. It is very evident to me that this is the only way in which you can work this part of your property in a systematic and economical manner, and if for any reason this scheme is not carried out you will be in the same position as you are at present. A fair amount of tin will be won for a time in the convenient period of the year, then the output will drop until such time as the dry season comes around again. Even the larger output in the dry season will have its limit and unless something now unknown is discovered it will get less from year to year for the reason that it is only your richer patches which can be profitably worked under existing conditions.

Prospecting. — During the next dry season when labour is available at least 8 or 9 boring machines under white supervision should be got to work. As your property covers such a large area that even with this plant it would take some 3 years to form any accurate idea of the value of your different areas, at the same time I think if prospecting were started early in the coming dry season and proper sections bored and planned the tonnage of tin contained in your top flats on the Danshandon and Cameroon areas would be fairly measurable and the same would be of great assistance both to your board and ourselves, as once we were sure of the values we could prepare the different portions for whatever installations of plant that would be necessary to meet each case.

General.—I have pleasure in stating that I am very pleased with the prospects of your company, as the areas held offer exceptional possibilities and there is every indication that developments will prove a large tonnage of tin to exist. I have already given you an approximate estimate of 1,019 tons, of which 119 tons for the Ouree and 400 tons for the Ahoo rivers upon the plateau; 400 tons for the Danshandon and 100 tons for the Cameroon areas; both the latter are below the plateau. As I explained before this estimate is only given as something for a guide, at the same time I feel that I am unfair to your properties in computing tonnage at all owing to their semi-prospected condition. In my own mind I am convinced that the areas below the plateau are very much under-estimated, but in the absence of real proof I cannot go further. As you will have noticed earlier in this report, I attach more importance to your areas below the plateau as, in my opinion, they have much wider possibilities, furthermore, can be so economically operated. The main factors in this case are the bringing in the water and the installation of elevating plant, afterwards the conditions will be such that it will allow of you winning your tin at a much lower cost than any other mine I have so far seen on this field, and your management will have no cause for complaint regarding the scarcity of labour which always occurs at this period of the year. In conclusion, I should like to state that I am receiving every assistance from Mr. Cousin, and please understand that if there is not sufficient prospecting done it is not due to any fault of his, for under very adverse circumstances this gentleman has accomplished as much as any other person could do on a property so extensive as yours.

I remain, Gentlemen,

Yours faithfully,

JOHN M. ILES.

JOHANNESBURG CONSOLIDATED INVESTMENT COMPANY, LD.

(Incorporated in the Transvaal.)

REPORT OF DIRECTORS

To be submitted to the Shareholders at a Meeting to be held in the Board Room, Johannesburg Consolidated Investment Company, Limited, Consolidated Building, Johannesburg, on November 27, 1917.

ACCOUNTS.—The Company's Balance Sheet and Profit and Loss Accounts for the financial year ended June 30, 1917, are submitted.

PROFITS.—After providing for depreciation, English and Colonial Income Tax, and other charges, the profit for the year amounts to £194,712. 12s. 3d., which, together with £161,343. 18s. 3d. brought forward, makes a total available balance of £356,050. 10s. 6d.

DIVIDEND.—On June 25 the Directors declared a dividend of 5% (free of Income Tax) as against a similar rate of dividend subject to Tax in previous years. This absorbs the sum of £197,500, leaving a balance of £158,556. 10s. 6d. to be carried forward.

VALUATION OF SHAREHOLDINGS.—As usual the Company has where necessary written down its shareholdings to their market value as at June 30 last.

FINANCIAL POSITION.—As indicated in the following paragraph, the Company has devoted part of its resources to the acquisition of new Mining interests, but retains a very substantial liquid balance in cash and Government securities.

MINES IN WHICH THE COMPANY IS LARGELY INTERESTED.—During the year your Company has acquired a controlling interest in the Randfontein Estates Gold Mining Company, the Randfontein Central Gold Mining Company, and the Langlaagte Estate and Gold Mining Company, and the administration of these properties has now passed into the Company's hands.

In this connection it may be mentioned that shareholders of the Randfontein Central Gold Mining Company, Limited, have been notified that, for reasons given, their new Board has considered it necessary to effect somewhat drastic changes in the previous mining policy of the Company. These changes will result in a temporary reduction in the Company's monthly profits, but it is confidently anticipated that the new policy will be to the ultimate benefit of all concerned.

The position of the other Gold Mines under the Company's control is clearly set forth in their respective Annual Reports, which have been recently issued.

In so far as the younger Mines are concerned, it will be seen that the returns and developments of the Government Gold Mining Areas (Modderfontein) Consolidated, Limited, have shown marked progress during the year under review. The ore reserves exceed 5,500,000 tons, the estimated value of which is about 7·2 dwt. per ton over 75 inches. The new reduction plant is in full commission, and is capable of dealing with 120,000 tons monthly. A satisfactory arrangement has just been concluded with the Government as regards certain anomalies under the original lease, and a very prosperous career for this Company is assured. Similarly the Van Ryn Deep, Limited, has shown excellent results, both as regards returns and development. The ore reserves of the Company now stand at well over 2,300,000 tons, the value of which has improved from 8·4 dwt. to 8·7 dwt. per ton.

The profits of all South African Mining Companies have naturally been adversely affected by the large increase in the cost of mining stores. Further, in view of the restrictions and difficulties attending the shipment of material required for mining purposes, it has been necessary to take prudent measures to guard against any shortage of supplies.

GOLD PRODUCTION.—The Company's Group of Mines, for the year ended June 30 last, produced gold to the value of £4,724,234. This amount does not include the production of the Randfontein Central and Langlaagte Estate Gold Mining Companies. It is anticipated that the value of gold will be produced by the Company's Group of Mines next year will approximate £10,000,000.

NEW AREAS.—During the year the Government offered two areas in the Far East Rand for public tender, and your Company made very substantial offers for both of them on the basis of their being worked as independent propositions. Certain Companies owning developed ground immediately adjoining made offers on the basis of amalgamation with their existing mines, and their proposals proved to be more acceptable to the Government Engineers.

DIAMOND MINES.—In view of the Company's considerable interest in all the leading South African Diamond Companies, it is of special interest to record that during the period under review, on the initiation of your Chairman, very important and far reaching arrangements have been made materially affecting the future prosperity of these properties.

For the first time in the history of these Mines an effective control of the quantity of diamonds to be annually produced and marketed has been established, which, even under present conditions, has resulted in a very large advance in the price of the stones. This limitation of production effecting as it does large savings in their annual expenditure, but owing to the enhanced prices not diminishing their revenue, will in normal times vastly enlarge the profits of these Companies and very materially extend the period during which their Mines can be profitably worked. The arrangements in question have been cordially approved and supported by the Union Government, who from a revenue point of view are largely interested.

ESTATES AND TOWN PROPERTIES.—There is little or no improvement to be recorded in the Company's revenue from this class of investment, but energetic efforts are being made to develop and popularize, for residential purposes, certain of the Company's suburban estates with considerable prospects of success.

CHAIRMAN'S VISIT TO SOUTH AFRICA.—During the year your Permanent Chairman, Mr. S. B. Joel, and your Consulting Engineer, Professor Lawn, paid a lengthy visit to South Africa. It will be seen from the Chairman's speech to the Shareholders at the Annual General Meeting that all matters affecting the Company's interests were carefully reviewed, and it is therefore unnecessary to refer to them in detail in this report.

Speaking generally, however, Mr. Joel dwelt upon the steps he had taken to broaden the basis upon which the future earnings of the Company rest, and your Board feel confident that the continued prosperity of the Company is fully assured.

By Order of the Board,

THOMAS HONEY, }
W. H. MARDALL, } *Secretaries.*

September 27, 1917.

RENONG TIN DREDGING CO. LIMITED.

Directors: Major F. B. Lawson (*Chairman*), Sir John Anderson, E. T. McCarthy, L. T. Leonowens, A. F. Nicol. *Consulting Engineers:* F. W. Payne & Co. *Secretaries and Agents:* Guthrie & Co. Ltd. *Office:* 5 Whittington Avenue, London, E.C.3. *Formed* 1908; reconstructed 1913. *Capital issued:* £25,000 in 15% cumulative preference shares, and £87,267 ordinary shares, both of £1 each.

THE ordinary general meeting was held on September 28 at the offices, 5 Whittington Avenue, London, E.C., Major F. B. Lawson (the Chairman) presiding.

The Chairman said it was his pleasant task to point to a successful year's working of the property and to place before shareholders a balance sheet which showed the company to be in a strong and satisfactory position. The issued capital now stood at £112,267, divided into 25,000 preference shares and 87,267 ordinary shares, the latter having been increased during the year under review by the taking up of the 10,500 shares which were held under option, as stated in last year's balance sheet. All debentures had been paid off and the cash position was strong. At the close of the accounts they had liquid assets of more than £53,000. A reserve fund was being built up, and already stood at £11,000; £1,201. 19s. had been written off buildings and machinery and £10,029. 8s. 11d. from the dredges. These latter, which were taken into the accounts at the time of the reconstruction of the company in 1913 at £53,040, had already been brought down to £34,000, and in this was included the annual heavy cost of repairs and renewals, which in the year under review amounted to £23,536. Notwithstanding difficulties in obtaining supplies from manufacturers and freight, they had been enabled to keep up the stock of spare parts, which at the time of closing the accounts stood at £17,674. The net profit for the year's working came to £29,511, as against £30,863 last year, while the working expenses were practically the same. The expenses over all amounted to 8·98d. per cubic yard—not quite a penny more than last year—but when the increase of prices generally was taken into consideration, the difference could not be called excessive. On the other hand, the value of the ground treated during the year was 13·29d., which was rather more than a penny better than last year; so that the net profit per cubic yard did not show much difference, just a fraction in favour of the present accounts. The amount of tin ore produced during the year amounted to 970·41 tons, against 827·50 tons obtained last year. The average price per ton of ore was £128·85 against £111·58, and the average assay-value of tin remained about 70%. During the year they had expended the sum of £1,020 in prospecting the 1,000 acre block, for which they held a special prospecting licence. The results showed that the lead had become split up as it approached the sea, and it was doubtful whether much of this particular area would be worth dredging. The board had, however, secured prospecting rights over other areas in the neighbourhood, which it was proposed to test as soon as the rainy season was over. The company incurred no liability for excess profits duty for the year under review, and although it was impossible to definitely state now what the position would be for the current year, it was possible that they might not be liable for this year also. The workshop had been of very great assistance and many of the less important spare parts required had been manufactured at the mine. He did not think he was unduly optimistic in anticipating that the current year would be equally profitable to the last. At any rate, they had begun well, as the amount of ore won for the first 2½ months was 195 tons. All three dredges were now in good working order, and the board was looking well ahead in the provision of spare parts, so that they hoped to avoid any undue stoppage caused by failure of supplies.

Mr. A. F. Nicol seconded the motion, and it was carried unanimously.

Professional Directory

The Mining Magazine

FOUNDED IN 1909 BY T. A. RICKARD AND EDGAR RICKARD.

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.SC., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill,* both Editions.

BRANCH OFFICES { 420, Market Street, San Francisco. 2,124, Equitable Building, New York.

SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XVII. LONDON, NOVEMBER, 1917. No. 5.

CONTENTS.

EDITORIAL

ONE of the American makers of incandescent electric lamps refers to argon, neon, crypton, etc., as the "noble" gases. The reference, no doubt, is to the noble lords in the opera, who "did nothing in particular and did it very well."

NEW words and expressions are continually being invented by ignoramuses. In a eulogy of a recently discovered lode, a man from the back blocks writes: "I have every reason to say that it should prove the most permanently tonnaged in the district." We hope this word "tonnaged" will not "permanently" settle in our language.

IMPROVEMENTS in procedure in connection with Patent Law are being continually suggested and sometimes introduced. It is a pity that some standardization cannot be adopted with regard to the subject-titles of the specifications. Some titles are meticulous in their precision, while others are so vague that the nature and application of the inventions are effectually masked. For instance, a recent title was: "Improvements in Compositions of Matter and Processes for Making Same." This might cover the electron theory or the manufacture of artificial milk; as a matter of fact it related to contacts for dynamo commutators. This freedom in choosing a title adds greatly to the labours of those engaged in research.

IN a recent issue we described the Francois cementation method for blocking the apertures through which water enters mine workings, incidentally mentioning that the method is to be employed at the East Rand Proprietary Mines. Another useful application has lately been found for the process at collieries in the Midlands, namely, to extinguish fire in a coal seam. We all know the fires that arise in the waste coal left behind in exhausted stopes or "goafs" due to the oxidation of pyrite in the coal, but fires in crushed pillars of coal are not so common. At one of the Warwickshire pits the shaft pillar began to burn, the combustion being encouraged by the ingress of air through innumerable cracks. The colliery was threatened with complete disaster, when the engineers fortunately thought of applying the Francois method. A hundred tons or so of the liquid cement was pumped into the pillar through bore-holes, whereby the crevices were firmly cemented and the fire extinguished.

WE have pleasure in announcing that Mr. Hugh F. Marriott is the president-elect of the Institution of Mining and Metallurgy. Mr. Marriott is an Associate of the Royal School of Mines, and is consulting engineer in London for the leading South African mining house.

THE death of George T. Holloway adds to the list of Associates of the Royal School of Mines who have been prematurely removed from their honourable activities during the last few years. With him may be classed Arthur Claudet, Bennett Brough, and Bedford McNeill. Men of their high character and attainments do much to reflect the real and legitimate business of mining and metallurgy, amid the whirl of insensate speculation and conscienceless over-capitalization characteristic of the London share market.

TWO years or more ago we wrote an editorial on "German Genius" and adduced evidence that this genius did not consist of the power of evolving new ideas but of the ability to carefully collect facts and to industriously apply ascertained principles. We were then referring solely to the domain of natural philosophy and engineering. Now comes a heavy bombardment of the German position in connection with surgery, delivered by Sir Berkeley Moynihan, the intrepid investigator and operator at Leeds. He says that the literature issued by Germany in connection with diseases is vast in quantity, prolix and turgid in style, lacking insight and interest, and almost utterly devoid of inspiration or original thought. In connection with surgery, the Germans are to be seen in their most characteristic phase as gleaners and harvesters. The seed has been sown by others; it is they that have guarded the crop, garnered it, gleaned every straw of it, and stored it in vast and ugly chambers. In capacity for original thought the German mind is lacking. The brilliant and happy inspiration, the penetrating insight, the new vision, these are things for which we seek almost in vain in German scientific literature. The fertile new thought giving a fructifying influence to the work of others is rarely of German origin. The German mind is of quite a different order. It is avaricious, industrious, methodical; it collects, if it does not accurately appraise, the work of others. It tabulates and registers and explains; it furnishes an intricate analysis, and illustrates by copious reference any subject with which it may deal. The new idea, originating almost always elsewhere, is given eager hospitality; is dissected and discussed at inordinate length; it may be put into practice with various alterations of technical procedure, and before long may be claimed as a home product. Sir Berkeley sums up by declaring that the German mind is deductive, patient, laborious, massive, but not original; that the German is not an innovator, but a renovator, not an explorer but an exploiter, not a creator but a collector. These are eloquent words and full of truth.

MANY important events go unnoticed nowadays owing to the larger claims of the war on the columns of the daily press. For instance, the opening of the Australian Transcontinental Railway was allowed to pass without any appropriate fanfare of trumpets. The line connects east and west, which have hitherto been as distinct communities as if they were separated by sea. Of the 1,300 miles between Port Augusta, in South Australia, and Kalgoorlie, in West Australia, more than two-thirds is through hitherto uninhabited desert. Unity of interest in railway matters in Australia was for long enough impeded by each state adopting a different gauge from that of its neighbours, and even within each individual state there has been no conformity to standard. Thus in South Australia, the gauge of the Kalgoorlie railway is 4 ft. $8\frac{1}{2}$ in., the line north of Adelaide is 5 ft. 3 in., and the railway to Broken Hill is 3 ft. 6 in. Since the inauguration of the Commonwealth, the rule has been to adopt 4 ft. $8\frac{1}{2}$ in., and, as opportunity and funds offer, to re-lay the old lines. A case in point of this rebuilding is the line from Perth to Kalgoorlie, which is to be widened from 3 ft. 6 in. when funds allow; while of new lines under construction that connecting Broken Hill with Condobolin, on the Sydney railways, has the standard gauge of 4 ft. $8\frac{1}{2}$ in.

Great Boulder Perseverance.

The decision of the directors of the Great Boulder Perseverance to suspend mining operations forms the closing chapter of an eventful history. It will be remembered that, after Hannan's find at Kalgoorlie in 1893, the whole district was pegged out by prospectors. At first the surface showings indicated auriferous veins nothing out of the ordinary, but afterward a little digging at a point about four miles south of Hannan's disclosed ore of unusual wealth. The Great Boulder, Ivanhoe, Lake View, and the Australia leases soon achieved world-wide fame. The Perseverance was longer in coming to the front. The property was introduced in this country by the late Zebina Lane, who was in the early days connected with Great Boulder. The British Westralia Syndicate had been formed by Mr. Frank L. Gardner, with the financial backing of the Barnato group, in order to handle West Australian business. At one time the late Woolf Joel was chairman of the company. After his death the Barnato interest diminished, and Mr. Gardner assumed entire control. The syndicate floated the Perseverance in August, 1895, and for a year or two the results of mining and milling the oxidized ore did not appear to be promising. In fact they did not warrant the erection of a treatment plant, and the ore was sent to a customs mill which the syndicate had erected. When the workings reached the sulpho-telluride zone, the controllers were not over pleased at the metallurgical problem before them. They, however, sought outside advice and engaged the services of Mr. Ralph Nichols, who came from America as consulting metallurgist in 1897, afterwards remaining as manager. After the treatment method had been settled, and the plant perfected, the prosperity of the company gradually increased. In 1902 the reserves were reported to be rich and extensive, and in 1905 the share capital was expanded from £175,000 to £1,500,000 in order that the capitalization should be nearer the market quotation. Next year came the historic crash, when it was suddenly found impossible to maintain the output of high-grade ore. A shareholders' investigation led to Mr. Gardner finding it convenient to reside abroad permanently. In 1904 the technical control was put in the hands of Messrs. Hooper & Speak. Mr. C. G. Klug was manager for a short time, and he was followed by Mr. G. W. Borrowe. In 1909 the local partners of Messrs. Hooper, Speak & Co. directed operations, first Mr. Ernest Williams and afterward Mr. R. A. Varden, with Mr. E. Devonport Cleland as manager. When the firm took matters in hand they found plenty of low-grade ore, and they set about reorganizing methods so as to secure substantial reduction of costs. It is only recently that we wrote of the efficiency of the methods obtaining at Perseverance during the last ten years, and that we published a paper giving details of the metallurgical practice. For a long time the average margin of profit has been small; with the present increase in the cost of supplies and labour, the balance is on the wrong side, and the end has necessarily come.

A New Mining Method on the Rand.

It is a matter of common knowledge that due provision for the support of the hanging wall was not a feature of Rand mining practice in the early days. With lodes that dipped at 80° the subject did not interest the engineers to any great extent. As the reefs flattened and the workings became deeper, the absence of adequate support became a menace. The danger was all the more serious because the change in conditions was slow and gradual, and the new factor in mining crept in almost unawares. Even when a few subsidences, falls, and rock bursts had taken place, engineers did not readily admit the cause, and there was even a discussion on earthquakes. When the subject could no longer be avoided, hydraulic filling of stopes by means of sandy tailing was adopted. This procedure, however, was soon found to have a limited application, being suitable chiefly for filling old stopes either preparatory to the withdrawal of ore from pillars, or merely to prevent the collapse of exhausted workings. As a means for making current stoping operations safe in dangerous ground it proved a failure. Further inquiry was therefore necessary. The engineers of the Central Mining group, in particular, have paid close attention to improving the conditions and to devising an alternative method. Their investigations are reflected in papers presented at a recent combined meeting of the South African Institution of Engineers and the Chemical, Metallurgical, & Mining Society of South Africa. In our Mining Digest we quote from the papers read by Messrs. Percy Cazalet and G. Hildick Smith. Briefly, the method adopted at Ferreira Deep is based on the longwall system, with the important difference that the broken ore itself is built into packs to support the roof. It will seen from a plan accompanying our abstract of the papers that half the area of the stope is filled with these packs. As the dip of the reef is about 29°, it would be impossible to build the packs without the aid of timber. The pigstye method was first applied, but this was found to use too much timber, and ordinary packing as shown in the illustration accompanying the abstract was adopted instead. When the whole of the stope is developed in this way, and there is no longer any need to support the hanging wall, the supports are withdrawn as in ordinary longwall mining, and both timber and ore are recovered. This method economizes timber, which is expensive on the Rand, and it obviates the necessity for additional mining and haulage, seeing that ore is used instead of rock or waste. The advantage of the packs is that they are capable of yielding slightly to the pressure of the hanging wall and thus obviating rock bursts. In this connection it is well to remember that coal-mining engineers continually discuss the relative advantages of the pillar-and-stall and longwall systems, which respectively use pillars of untouched coal and wood or stone substitutes for supporting the roof. One of the most interesting proposals in this connection was that made by Messrs. W. H. and B. H. Pickering, who suggested that no shaft pillar of coal should be left, but that a pillar of stone packing should be substituted. We gave some particulars of this method in our issue of July, 1912. It was argued that by this means the subsidence would be more gradual and even, and that in consequence there would be less likelihood of the shaft getting out of line. Moreover the risk of spontaneous fires due to the crushing of the coal in the shaft-pillar and elsewhere would be avoided.

"The Mineral Industry."

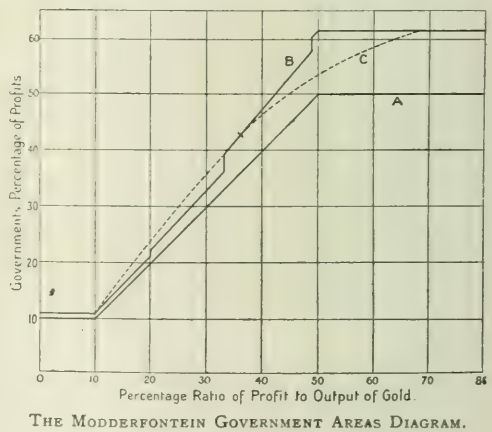
The publication of the twenty-fifth yearly volume of "The Mineral Industry" is a notable event in the history of technical literature, and it is appropriate that a review should be written containing something more than a mere recital of the principal contents. The present editor of this Magazine assisted in the preparation of the first volume, happening to be in America at the time, and during the next dozen years did much to cultivate a due appreciation of the year-book in the Old World. It is natural, therefore, that he should take a special interest in its fortunes.

"The Mineral Industry" was founded in 1892 by the late Richard P. Rothwell, who for so many years had been the mainstay of the *Engineering and Mining Journal*. It had been his custom to give a general statistical review of the progress of mining in the first issue of the *Journal* each year. The United States Geological Survey had issued (and still issues) yearly reports of this character, but their publication was so long delayed that the figures were of little current interest; and, besides, no cognizance was taken of events outside the United States. Mr. Rothwell held that promptness of publication of records of output was of greater value than absolute accuracy, and also that details of technical progress should cover the doings of the whole world. He was a man of cosmopolitan sympathy. Of Irish descent, he was born in Canada, and educated in France. He had many friends and admirers in Germany, in the days when University professors there were teachers of technology and scientific investigators, not political agents. He started his professional career in America among the Pennsylvania coal-fields, and subsequently had experience in iron mining, before he passed to gold and silver, copper and lead. For this reason he obtained a well balanced judgment of the relative values of the various mineral products of the earth, metallic and non-metallic, and was not obsessed with an exaggerated view of the importance of the noble metals. It will be seen, therefore, that he had special qualifications as editor of the *Engineering and Mining Journal* and its annual statistical numbers. But as time went on it was found that promptness could not always be secured, and that many contributors failed to respond to his exhortation in this direction. In 1892 the editorial staff of the *Journal* held a general consultation on the subject with their chief, and various proposals were discussed for modifying the form in which the statistical number should be published. Eventually the suggestion of Mr. Charles Bullman was adopted, that the number should be issued as a separate book of large octavo size about two months after the end of the year, and that the technological reviews should be expanded. Mr. Rothwell also decided that special monographs on technical questions of current interest should be included and that the name of the volume should be "The Mineral Industry: Its Statistics, Technology, and Trade, in the United States and Other Countries." Mr. W. R. Ingalls, who had previously been assistant editor of the *Journal*, came back to devote his attention to "The Mineral Industry." Among others on the editorial staff were Mr. Bullman, who contributed the chapter on platinum, Mr. Louis Janin, Jr., who wrote on his early experiences with the cyanide process, Dr. W. B. Phillips, the translator of Wedding's "Basic Bessemer Process," and Mr. Edwin Lefevre, who in later years achieved fame as a novelist and writer of short stories. The volume was issued in March, 1893, and was presented, in unbound form, to subscribers to the *Journal*; separate copies were sold at $2·00 unbound, and $2·50 in brown cloth. The value of the book was immediately recognized, and Mr. Rothwell was encouraged to go ahead and still further develop the idea. The next year the volume was twice the size, and was issued in brown cloth at $5·00, no rebate being granted to subscribers to the *Journal*. And so for nine years the venture progressed, until in 1901 Mr. Rothwell died. Here let it be said that as a money-making concern, "The Mineral Industry" was a failure; but, for that matter, so was the *Journal*. Mr. Rothwell cared little for money; he did not understand the art of gathering advertisements as do his successors in the ownership of the *Journal*; he put all his available surplus back into the business. He was entirely absorbed in his editorial work and in scientific and engineering problems arising out of it. Thus his successors in the ownership of the *Journal* did not know what to do with "The Mineral Industry." Dr. Joseph Struthers conducted it with distinction for two years, but on his acceptance of the secretaryship of the American Institute of Mining Engineers, the publication was allowed, in a way, to drift. About this time Mr. T. A. Rickard and the late W. J. Johnston bought the *Journal*. Mr. Rickard frankly admitted that statistics did not interest him, and he, moreover, urged that the inclusion of technological monographs in the volumes militated against the *Journal*, for he felt that what "The Mineral Industry" gained the *Journal* lost. Thus the twelfth and thirteenth volumes were not so liberally supplied with technical information, and they partook largely of the nature of general reviews. At the same time, it was sought to stimulate their sale by making the price $3·50 to subscribers to the *Journal*. After the issue of the thirteenth volume, Mr. Rickard sold his interest in the *Journal* and bought the *Mining and Scientific Press*, and Mr. W. R. Ingalls succeeded him as editor of the *Journal*, assuming also the duties of editor of "The Mineral Industry." The then owner of the *Journal*, the late John A. Hill, made the price of the volumes $10·00, but later he became tired of the book business and handed the books published by the *Journal*, including "The Mineral Industry," to the McGraw-Hill Book Co., a company formed to consolidate the book businesses of Mr. James H. McGraw and Mr. Hill. Mr. Ingalls then retired from the editorship of "The Mineral Industry." Mr. Albert H. Fay was responsible for Vol. 19, and Mr. Charles Of for Vols. 20 and 21, while the subsequent volumes have been in the hands of Mr. C. A. Roush. Naturally a great many contributors to the pages of the work have come and gone during the twenty-five years. The only name that has appeared without a break is that of Dr. H. O. Hofman, who has every year supplied a review of progress in the metallurgy of lead. Professor R. H. Richards has reviewed ore-dressing for the volumes from 2 to 25, and Professor J. W. Richards has written on aluminium for the same length of time. The man who has done the most for his old chief is undoubtedly Mr. W. R. Ingalls. Whether as assistant editor under Mr. Rothwell, or subsequently as editor, he collected vast masses of information and wrote much to which his name was not specifically attached. Moreover his advice and records have always been at the service of his successors, and, of course, his reviews of the metallurgy of zinc have always been highly appreciated. Our readers may expect us to conclude this article by answering the question: Why cannot a year-book similar to "The Mineral Industry" be established in this country? But that, as Kipling says, is another story.

Far East Rand Leases.

There is now a general agreement between the South African Government and the mining houses with regard to the terms on which gold-mining leases shall be granted in the Far East Rand. Until recently much uncertainty prevailed as to the best method of developing the gold deposits in the great basin. The cause of this was largely due to the hesitation of capital to follow the lead of the Modderfontein Government Areas, the first company to work on Government lease, owing to the onerous nature of the terms involved. Bids subsequently made for other areas were not sufficiently favourable to the Government and they were rejected. Then arose various proposals for the Government to work the deposits, but for various good reasons, already recounted in our columns, the principle of State-mining was rejected. While the State-mining controversy was raging, the mining houses gradually drew closer to the Government, and came to the conclusion that mining and financial operations could be conducted satisfactorily to them and to shareholders on a basis giving a comparatively larger share of the profits to the Government than they had hitherto offered. The settlement of suitable terms for the Brakpan South and Modder East areas last year constituted a triumph of diplomacy on both sides. It removed all doubt as to future policy, and promptly led the way to the offering of other areas. At the same time the defects of the original lease, that of the Modderfontein Government Area, were recognized by the Government, and recently this has been slightly modified, though not in any important particular. The present is an opportune time to examine the terms of typical leases, as disclosed in official announcements that have been made with regard to the Brakpan and the Modderfontein Government Area agreements. Detailed consideration of the Springs and Rietfontein bids, to which reference is made elsewhere in this issue, is postponed to another occasion.

When the Modderfontein Government Area lease was arranged in 1910, the general principle of the super-tax was admitted, that is to say, the greater the profit the greater the rate of tax. The ability to pay tax was calculated on the ratio of net profit (after allowance for amortization) to gross output, the higher the ratio the greater the Government's share in the profits. The terms fixed were as follows: A tax on a sliding scale was arranged as a basis of "minimum consideration specified by the Government," giving the Government from 10 to 50% of the profits. It was also arranged that the company should pay an additional 7½% of this tax when the latter did not exceed 20% of the net produce, 10% from 20 to 33⅓%, 17½% from 33⅓ and 49%, and 22½% for anything above. The basis tax and the total tax are



THE MODDERFONTEIN GOVERNMENT AREAS DIAGRAM.

marked in the accompanying diagram. This system of taxation or profit sharing was free from the statutory 10% dividend tax and the war levy. Like many other tentative arrangements, these terms were found by experience to be, in some circumstances, distinctly oppressive on the company, and did not encourage the engineers to reduce the costs or to increase the grade of the ore treated. A specific example of these anomalies may be given. Suppose the yearly amount of ore treated is 1,200,000 tons and the average yield per ton is 30s. If the cost per ton is 20s. the profit, after allowance for amortization, will be £551,000, of which £365,500 will go to the company and £185,500 to the Government. If the engineers succeed in reducing costs to 15s. per ton, the net profit will be £851,000, of which £378,200 will go to the company and £472,800 to the Government. It will thus be seen that of the saving of £300,000 effected by greater efficiency of work, the company receives only £13,000, while the Government takes £287,000. Obviously some modification of the lease, having for its object the elimination of such crudities, was only equitable. A new system of fixing the Government's share has therefore been arranged, based on formulas that mitigate the rapidity of the rise of the Government's share when the ratio of profit to output increases beyond 40%. At the same time the Government's share when the profits are lower are slightly higher than was the case in the original lease. The new rate is shown in the dotted line in the diagram. This line crosses the old one at a point where the Government's share is 42½% and the ratio of profit to output 36%. Below this point the formula is:

$$y = 5{\cdot}467 + 1{\cdot}06487\,x - \frac{53{\cdot}66}{x}$$

Above this point the formula is:

$$y = 82{\cdot}5 - \frac{1446{\cdot}81}{x}$$

where y is the Government percentage, and x is the ratio of profit to output. Specific figures for the company's and the Government's shares of the profits are as follows:

Ratio % of profit to Output (x)	Government's Percentage (y)	Company's Percentage
10	10·75	89·25
15	17·6	82·4
20	24·0	76·0
25	30·0	70·0
30	35·5	64·5
35	41·2	58·8
40	46·3	53·7
45	50·2	49·8
50	53·4	46·6
55	56·1	43·9
60	58·3	41·7
70	62·3	37·7

The new Brakpan lease is arranged on a different basis from that of the Modderfontein Government Areas, for the company also pays the 10% profits tax and the war levy. The agreement provides that for the first five years 5% of the profits shall go to the Government, and that afterward the Brakpan shall pay a percentage of its profits calculated by the following formula:

$$y = 50 - \frac{1150}{x}$$

subject to a minimum percentage of 12½. We append herewith a number of specific instances of the Government's and the company's shares of the profits:

Ratio % of Profit to Output (x)	Government's Percentage of Profits	Ratio % of Profit to Output (x)	Government's Percentage of Profits
10	12·5	50	27·0
20	12·5	55	29·0
30	12·5	60	30·8
35	17·1	70	33·6
40	21·2	80	35·6
45	24·4		

The Brakpan lease involves the application to the old Brakpan mine of the principle of payment of a share in the profits to the Government. In estimating the incidence of taxation it is necessary to remember this fact, and not to suppose that the new lease refers solely to the new areas. It is difficult for the outsider, for this reason, to judge of the actual merits of the contract, in comparison with that of the Modderfontein Government Areas. Such a calculation would require full knowledge, not only of the present ore reserves, but of the prospects in the undeveloped area and the plans for future increase of the rate of extraction of the ore. Another difficulty in the way of judging the contract is that it is not quite certain, as far as available information goes, whether the 10% profits tax is to be paid by the company on the total profits or only on its own share of the profits. Taking these circumstances into consideration it is impossible for the outsider at the present time to examine the Brakpan lease minutely; but judging by such information as we have, the Brakpan lease appears to be much more favourable to the operators than that of the Modderfontein Government Areas.

Before leaving the subject of Government leases, it is desirable to say that, on general principles, the proportion of Government profit should not be unduly augmented when the engineers increase the profits by decreasing the costs, but that on the other hand there is not the same objection to the Government taking a bigger share of the profit due to increased gold content. Some critics have said that this argument is valueless because the companies can regulate the assay-value of the ore sent to the mill, and can unsweeten the higher grade ore by reducing the percentage of rejection of waste or even by including barren rock. To this we rejoin that the proper fulfilment of the contract is closely watched by the Government engineers and that such tactics would not be allowed.

REVIEW OF MINING

Introductory.—Following on the Russian collapse has come a strong German-Austrian attack on Italy, and at the time of writing the outlook in that theatre of war is gloomy. In mining circles interest has centred on the Far East Rand, where two new leases have been granted by the Government; this subject is discussed at some length in an Editorial and also on this and the next page. East Rand Proprietary Mines made a loss on operations during October, and it has been decided to restrict development to the two sections where prospects are most hopeful so as to bring the expenditure down to the requisite level. The position of many of the low-grade mines on the Rand owing to labour shortage and high cost of supplies is receiving the anxious attention of the controllers. It is believed that unless the Government assists in some way closing down may become necessary. The silver market has gradually subsided into a more normal state. The price of tin has been strong owing to shortness of supplies.

Transvaal.—The output of gold on the Rand during October was 724,846 oz. and in outside districts 26,444 oz., making a total of 751,290 oz., worth £3,191,279, as compared with 712,881 oz., 25,350 oz., 738,231 oz., and £3,135,807 during September. The number of natives employed at the gold mines at the end of October was 170,331, as compared with 171,334 at the end of September, and 199,333 at the end of October last year.

The Government has given its decision with regard to the offers for the four new areas in the Far East Rand. The area marked (*A*) on the map, comprising Springs Farm and the southern part of Geduld has been awarded to the Barnatos, and the area (*C*), or south-east Rietfontein, has gone to Springs Mines. It is stated that unsuccessful tenders for (*A*) came from the Central Mining, the Albus, Lewis & Marks, Geduld Proprietary, and the Anglo-American Corporation. The unsuccessful bidders for (*C*) were the Barnatos, Messrs. Lewis & Marks, and Mr. J. Dale Lace. The other two areas, (*B*) and (*D*), were withdrawn by the Government owing presumably to the terms not being sufficiently good. It is reported that bids were made for south-west Rietfontein (*D*) by the Central Mining, Springs Mines, Mr. J. Dale Lace, and Messrs. Lewis & Marks, and that the solitary bid for east Geduld (*B*) came from Messrs. Lewis & Marks.

With regard to the foregoing results, the terms offered by the Barnatos for area (*A*) seem quite prodigal in their liberality, and a bigger share will go to the Government than is already obtained by the historic Modderfontein Government Areas. In an editorial this month we refer to the latter agreement as almost oppressive to the operator, but according to the new lease an even larger share of the profits will go to the Government. The Government's share will be calculated by the formula

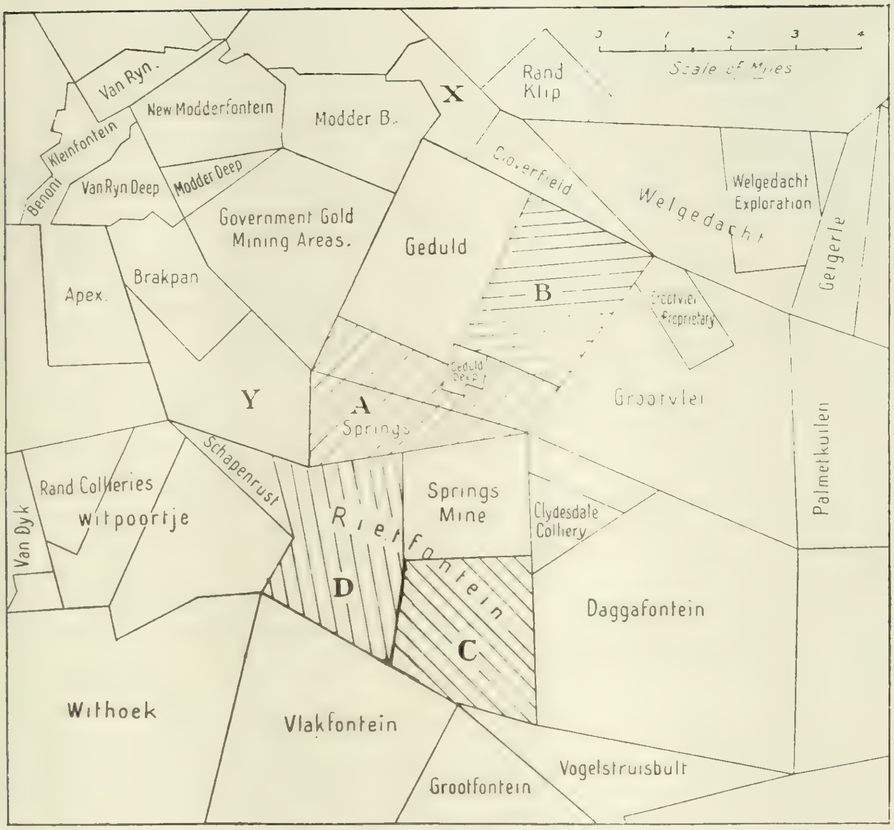
$$y = 80 - \frac{750}{x}$$

A little figuring with this formula will show that the Government would receive 50% of the profits when the ratio of profit to output is 33%, and nearly 70% when the ratio is 60%. In addition to this, the company will have to pay the usual profits and other taxes, which was not the case with the Modderfontein Areas. It is generally supposed that area (*A*) contains the choicest ground in the Far East Rand. Hence, no doubt, the competition. With regard to the area (*C*) acquired by Springs Mines, a glance at the map will show that the new ground follows the trend of the ore-shoots as indicated by Dr. E. T. Mellor, and therefore can be conveniently worked by an extension of the present lay-out. Moreover it adjoins the Daggafontein, which is now in the hands of the Consolidated Mines Selection, the controller of Springs Mines. With regard to the bid for eastern Geduld (*B*) the plan of Messrs. Lewis & Marks would have been to amalgamate it with Grootvlei.

The terms on which Springs Mines gets area (*C*) provide that for five years the company shall pay 5% of its profits for the amalgamated property, and that thereafter the formula shall be

$$y = 55 - \frac{1175}{x}$$

with a minimum of 12½%. These terms are not greatly different from those applying to Brakpan as outlined elsewhere in this issue, but the proportion of Government profit is rather higher The capital required for the development of the new ground will be provided by the Consolidated Mines Selection Co. and the Rand Selection Corporation. The total amount to be spent on development and equipment is £850,000.



THE FAR EAST RAND.

The interest in the Far East Rand has not, however, been confined to the new Government areas, for attention has also been attracted to the Heidelberg side of the basin where Sub-Nigel is once more to the fore. It will be remembered that in the early days the Nigel outcrop mine gave excellent returns. On the other hand the Nigel Deep and the Sub-Nigel (now consolidated under the name of the latter), on the dip, did not give such good results, and naturally the theory of impoverishment at depth was quoted. Since then, the knowledge of the continuity of the reefs between Heidelberg and Modderfontein has put a different complexion on conditions, and Sub-Nigel was encouraged to continue exploration farther into the basin. The adventure has been rewarded with success, so much so that the Treasury has permitted the issue of new capital to the extent of £300,000. With these additional funds the company will be able to sink a vertical shaft to tap the new ground. But this is not all, for additional property to the north covering about 500 claims is to be acquired on the Grootfontein Farm in exchange for 130,000 shares. The control of the Sub-Nigel company is with the Consolidated Gold Fields, which also holds an eighty per cent interest in the Grootfontein Farm. Full particulars of the new scheme will be available shortly. In the meantime we express our gratification at knowing that the Consolidated Gold Fields is to have a substantial share in the development of the Far East Rand.

Mr. W. E. Bleloch continues his activities in the Heidelberg district, where his Vaal River Gold Estates is prospecting on a property at Marievale, where a continuation of the Nigel outcrop is being investigated. Mr. Bleloch has his own theories of Far East Rand geology. Last month an announcement was made by him of a rich strike, only to be withdrawn next day. It would be advisable if a rather clearer statement was made as to what is really going on.

As mentioned last month, the Consolidated Main Reef is to absorb the Main Reef West property. To effect this consolidation 323,238 shares of £1 each in the Consolidated Main Reef are to be issued, of which 98,238 shares will go to the Main Reef West company and

225,000 shares to the holders of £250,000 Main Reef West company's debentures. As regards future mining plans, it is stated that a large proportion of what has hitherto been the most profitable area of the Main Reef West can be conveniently worked by the extension of the western drifts from the west incline of the Consolidated Main Reef into the eastern section at the Main Reef West.

The report of the East Rand Proprietary Mines for the quarter ended September 30 contains the melancholy information that development is to be curtailed and confined entirely to the most favourable areas. Before making this decision, the directors had considered the possibility of suspending milling operations during the war, or until a better supply of native labour could be obtained and the cost of stores had been reduced. It was found, however, that the standing charges, particularly that of pumping, would have soon made short work of the cash assets, and it was therefore necessary to keep the mine going and restrict the exploration and development. The directors propose to continue development on the Driefontein section and to the east of the Cinderella eastern boundary; also to continue to sink the vertical shaft and extend the 26th level cross-cut to intersect it. During the nine months to September 30, the payable ore developed was 267,000 tons, as compared with 841,000 tons sent to the mill from the reserves. The restriction of development will deplete the ore reserves even more rapidly.

Witwatersrand Deep is being hit by labour shortage and cost of supplies, and in all probability no profit will be earned for the current year. Dividends on a satisfactory scale were paid from 1906 onward, but about a year ago the market value of the shares began to drop seriously. There is still a considerable amount of ground to be explored, but to test this will require the further sinking of the incline. As the directors speak of the serious diminution of cash resources, the outlook as regards mining and development appears to be uncertain.

It is announced that an action is being brought by Randfontein Estates against the late controller, Sir J. B. Robinson, and that the amount claimed is over £400,000. It will be remembered that the Barnatos purchased the control of the Randfontein Estates and the Randfontein Central about a year ago. Details of the claim are awaited with considerable curiosity, to say the least.

Rhodesia.—The output of gold during September was worth £291,367, as compared with £294,359 during August and £322,035 during September last year. None of the regular producers shows any notable variation. Other metals and minerals produced during September were: silver, 17,691 oz.; copper, 337 tons; coal, 50,688 tons; asbestos, 769 tons; chrome ore, 5,266 tons; wolframite, 2 tons; diamonds, 87 carats.

The Rezende episode has infused a little of the old dramatic element into Rhodesian mining. For many years this group of mines has had an unexciting life. A few months ago, however, an unexpected stroke of luck was announced, for in the eastern workings ore of much higher grade than usual was discovered. The report issued stated that, on the 350 ft. level, a run of ore extending 676 ft. averaged 26 dwt. over 61 inches. Development was at once started to investigate the continuity of the ore in depth. In the meantime Sir Abe Bailey saw a good opportunity in this episode for a speculation, and bought up as many shares as possible. He has now obtained control and ejected the old board, and he proposes to remove the head office from London to Rhodesia. The market price of the shares has been booming; their actual value depends entirely on the results of present developments. A recent progress report gives encouraging news.

The Selukwe Gold Mining Co., one of the Bechuanaland Exploration Company group, has made a satisfactory cash deal with a tributer in connection with its gold mine, and is now proposing to devote its attention and funds to the Kafue Copper Company's property in Northern Rhodesia. The Kafue Co. also belongs to the Bechuanaland Exploration group. The parent company is joining the Selukwe in putting up capital for the development of the copper deposits. These deposits include the Silver King, Sable Antelope, Crystal Jacket, Hippo, and others, and some are at present being worked on tribute. They are situated about 100 miles to the west of the railway at Rhodesia Broken Hill.

The second lead-smelting furnace was started at the Rhodesia Broken Hill lead-zinc mine on October 12, the first having been put in commission on June 25. The output of lead was 412 tons in July, 478 tons in August, and 520 tons in September. Mr. Edmund Davis has joined the board, and an engineer representing the Central Mining & Investment Corporation is investigating the property with a view to the corporation taking an interest. We published a résumé of Mr. S. J. Speak's report on this property and the methods of smelting in our issue of August last year.

West Africa.—The output of gold during September is officially reported at £127,168, as compared with £130,278 in August and £127,138 in September, 1916. Prestea Block A still shows a declining yield and profit.

The West African Mines, Limited, is to go into liquidation, and the assets are to be distributed. The company was formed in 1910 by the Consolidated Gold Fields of South Africa, for the purpose of examining and proving gold mines in West Africa. Mr. T. J. Milner, of the Central Mining & Investment Corporation, and Mr. Edmund Davis, whose connection with the Gold Coast and Nigeria is so well known, were also on the board. The company had no luck among gold prospects, and turned its attention to tin mining in Nigeria. Mining leases were acquired, and shares purchased, notably in the Ropp and Rayfield companies. Three years experience of adverse conditions has made the controllers decide to abandon hopes of success, and a meeting of shareholders has confirmed the resolution to wind up. The Ropp shares are to be distributed among shareholders, the mining leases are to be sold, and the other assets are to be realized to the best advantage.

Congo State.—The Belgian Minister for the Colonies has issued a report on the economic development of the Congo State. According to this report the gold mines of Kilo and Moto in the eastern province produced 57,876 oz. in 1914 and 102,890 oz. in 1916. In the Kasai district the yield of diamonds was 15,000 carats in 1913, and 54,000 carats in 1916, while the estimate for the output for 1917 is 85,000 carats.

Australasia.—The labour conditions have improved slightly. The serious position due to shortage of fuel supply has been relieved. Mining has been resumed at Broken Hill. In New South Wales and Victoria a recurrence of heavy rains unusual in Australia has caused many floods.

Owing to continued difficulties it has been decided to close the Mount Elliott smelter until the New Year, and in the meantime to provide additional labour-saving appliances. It will be remembered that, on the expansion of the company's mining interests a year ago, the smelter was reorganized on a larger scale, and that operations were resumed in March of this year. The capacity is 700 tons of blister copper per month. During October the plant ran 18 days, and treated 5,300 tons of ore for a yield of 222 tons of copper. The smallness of the output well indicates the present unsatisfactory labour conditions.

Malay.—The incidence of the excess profits tax on a new company is harsh, as we have often remarked. The Kamunting Tin Dredging Company affords a good example. In the report for the year ended June 30, a profit of £15,926 is shown. Unfortunately the company has had to pay out of the balance in hand no less than £14,875 as excess profits duty and also £4,392 as income tax for the previous year, so nothing was available for shareholders. The two imposts are equal to 15% on the issued capital. The company has now passed its critical first three years of profits, and current and future earnings will not show any excess over the average of those three years. An interim dividend for the present year has already been declared.

Cornwall.—Our Camborne correspondent sends us information of the activities of the recently established Cornish Chamber of Mines, and mentions that the council has succeeded in persuading the Boundary Commissioners under the Redistribution of Seats Bill to preserve the "Mining Division." It is well that the existence of a non-ferrous metal mining industry in this country should continue to be impressed on Parliament and the Government. The council has called a meeting for November 15, when suggestions on subjects of interest will be welcomed. In all probability many proposals for the Chamber's participation in matters of public and administrative importance will be received.

Canada.—Development at Porcupine is being pushed on a more extensive scale than ever. The difficulty arising from labour shortage has been partly overcome by voluntary wage increases either by an advance in the base rate of pay or the payment of special bonuses. There are now upwards of 200 drills engaged on this work at Porcupine and Kirkland Lake. At the Dome Mines, the question as to the advisability of closing down the mill entirely until labour conditions showed improvement was lately under consideration, but it was finally decided to continue milling. At the Hollinger large additions have been made to the ore reserves. A depth of 2,000 ft. has been reached by diamond-drilling, and the results indicate that the veins continue to that depth.

The success of the Crœsus mine has stimulated mining activities in the Matheson district, Munro Township. The water difficulties which hindered operations for some time have now been overcome, and work on the lower levels has been resumed. The ore as sent to the mill averages over $40 per ton. This is the highest grade ore treated in Northern Ontario. At the Buff-Munro, a mile from the Crœsus, two shafts have been sunk to 50 ft. and a mining plant has been ordered. The Burton-Munro company has 40 men at work, and the shaft is down 265 ft. It will be remembered that Crœsus ore formed the subject of an unusually effective picture in colours on the outside cover of the *Canadian Mining Journal*; this is now reprinted as a frontispiece for the Canadian Mining Manual.

United States.—Being defeated in the Courts, the mining companies unwilling to pay royalties to Minerals Separation are resorting to a campaign of personal abuse. They allege that the Minerals Separation North American Corporation is controlled by German interests, and that the real aim of their actions for infringement is to stop production of the metals required in war. The only basis for such a supposition is that Beer, Sondheimer & Co. used to be the American commercial agents for Minerals Separation. It is true also that a producer defeated in the Court may have to suspend operations pending appeal unless it can give an adequate bond for indemnity. But Minerals Separation does not wish to stop operations. In the case of the Butte & Superior, the company alleged that it could not find the requisite bond, though we think it would have been successful in doing so if it had had another try. Minerals Separation is prepared to waive the bond, rather than force the closing of the mine. We regret to say that the companies operating at Cobalt, Ontario, are also making the same insidious attack on the owners of the flotation patents. Many Cobalt mines are using flotation to advantage.

It is announced in the daily papers that sulphur deposits in the Pecos district, Texas, have been acquired by an unnamed British purchaser. These deposits are situated on the western side of the Pecos river, a tributary of the Rio Grande, in the portion of Texas lying between Mexico and New Mexico. They have been known for sixty years, and attempts have been made to develop them by many different parties. The sulphur is in elemental form and is disseminated through porous ground near the surface. The richest parts may contain 30% of sulphur. Mining would be by open-cut, and the ground would be treated with steam or hot water, for the recovery of the sulphur. The origin of the sulphur has been much discussed by economic geologists. Trustworthy authorities have generally recommended judicious examination and consideration of the problems involved and have deprecated rash adventures. No doubt the great demand for supplies of pyrite or sulphur for explosive manufacture has turned serious attention to these deposits.

The output of quicksilver in the United States during 1916 was 29,932 flasks of 75 lb., valued at $2,576,547, or $86 per flask. These figures showed increases of 8,899 flasks and $749,635 over those of 1915.

The labour situation at the copper mines in western America has improved, but it will take some time before the mines that are re-starting get to their normal level of production, for one reason and another. The Arizona Copper Company, though the strike is settled, will not be able to resume full output owing to a serious fire in the Coronado mine.

Portugal. — The directors of Mason & Barry announce that, owing to the scarcity of steamers of moderate size and the exercise of control of shipping, the exports of pyrite have been greatly restricted during the current year. The total amount despatched during the first nine months of the current year has been only 35,725 tons, as compared with 151,424 tons during the corresponding period in 1916.

Russia.—Amid all the uncertainty as to conditions in Russia, it is well to give such details of mining operations as come to hand. The July figures for the Kyshtim were issued at the beginning of this month. The ore raised from four mines was 19,738 tons averaging 2·69% copper. The amount of ore smelted was 20,005 tons yielding 350 tons of blister copper. The output at the refinery was 447 tons of fine copper. An estimate of ore reserve is as follows: Koniukoff 116,316 tons, Smirnoff 187,619 tons, Karpinsky 59,790 tons, Americansky 22,051 tons, Ivanofsky 9,640 tons, total 395,416 tons.

The Irtysh Corporation reports that during September 490 tons of oxidized lead ore from the Ridder mine averaging 18% lead, 30 oz. silver, and 1 oz. gold was sent to the Ekibastus smelter, together with 377 tons of zinc concentrate and 144 tons of lead concentrate. The concentrator at the mine treated 1,039 tons of ore yielding 309 tons of zinc concentrate and 84 tons of lead concentrate. At the Ekibastus smelter, 30 tons of spelter was produced and 42 tons of refined spelter shipped.

Last month we recorded that the dredging results obtained during the past season by the Orsk Goldfields had been disappointing. It has since been announced that operations at the Pokrovsky dredge were suspended on September 26 owing to poor extraction and shortage of water.

THE KANBAUK WOLFRAM MINE

LOWER BURMA

By HARRY D. GRIFFITHS, A.R.S.M., M.Inst.C.E., M.Inst.M.M.

As a continuation of his article published in the August issue on conditions connected with wolfram mining in Burma, the author gives particulars herewith of a mine which is being reorganized on modern principles.

IN the July issue I gave a general outline of conditions in Burma in connection with wolfram mining. A short description of the work which is now being done, or contemplated, at one of the chief mines may prove of interest, and draw attention to the possibilities of the district.

HISTORY.—This property had been worked sporadically for tin, which was found on the banks of the creek, by Chinese workers. No notice seems to have been taken of the wolfram which was found in connection with the tin, nor of the lode outcrops showing wolfram in abundance on the slopes of the hills, until the property was taken under a prospecting license in 1912 by Col. Radcliff and a few friends. Attention was immediately given to the prospecting of the wolfram outcrops, which at once yielded more than sufficient ore to pay expenses. In 1913 the property was incorporated in Radcliff & Co. Ltd. The profit earned to that date enabled the company to erect a 10 stamp mill, and also a flume line to test the talus by means of hydraulicking. Since that time an enormous amount of development has been accomplished on the lodes and all plant, buildings, etc., were put up out of profit. The talus deposit was thoroughly prospected by means of pits and bores. A scheme for working it on an adequate scale, for which a large amount of capital would be required, led to a reconstruction of the company under the title of the Kanbauk (Burma) Wolfram Mines Ltd., registered in Burma with an issued capital of Rs 21,00,000 in shares of Rs 15 each, and Rs 7,50,000 in convertible debentures.

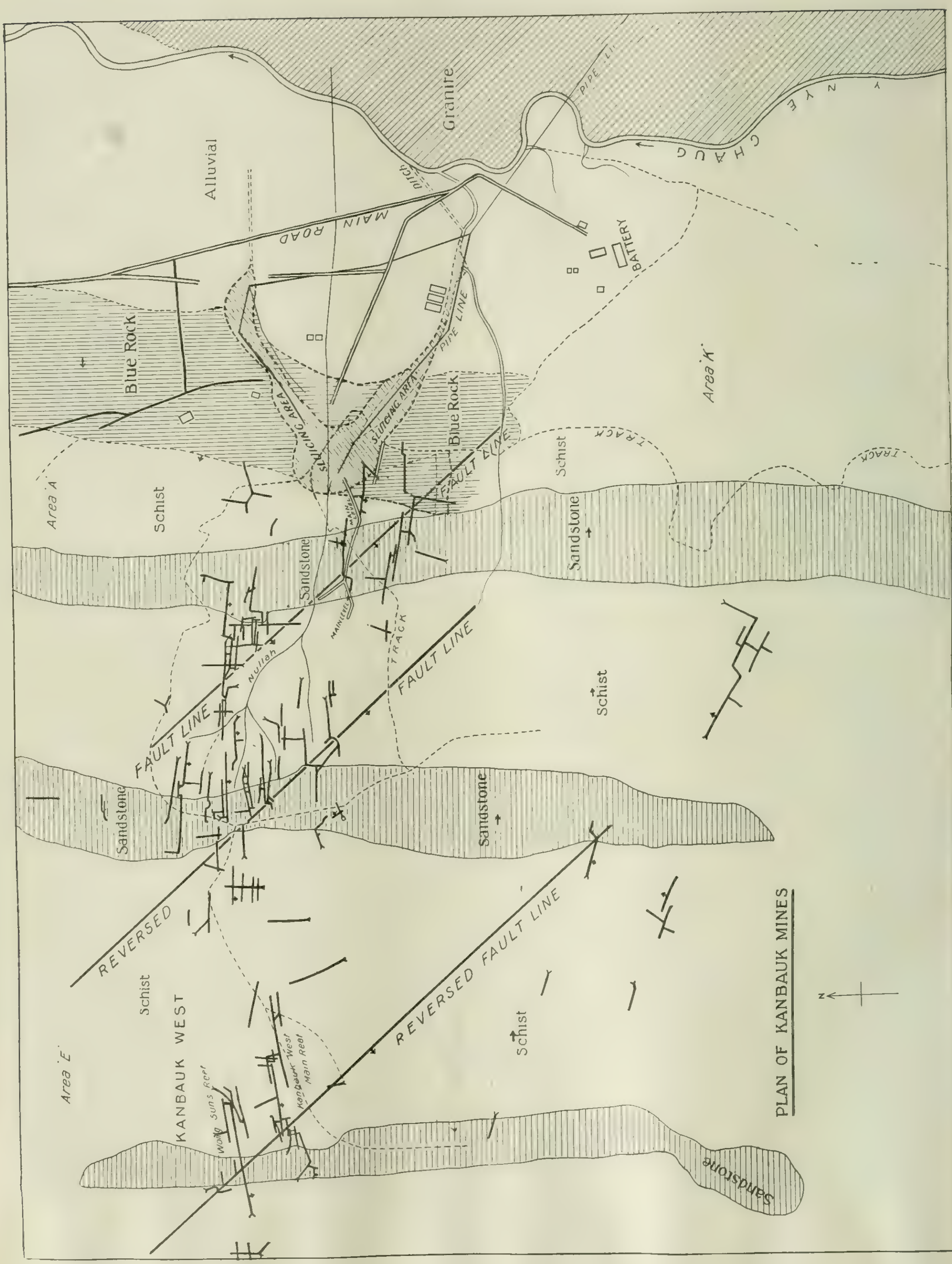
GEOLOGY.—The country rock in which the lodes occur consists of a series of schists, with well defined pressure planes striking north and south, and dipping sharply to the east toward the granite which outcrops in the eastern portion of the concession. The schists vary in texture and range from fine-grained schists to fairly coarse sandstones, the variations being seldom sharp and well defined.

Contrary to the usual occurrences in Lower Burma, the mineralized zone carrying the lodes runs in an east and west direction at right angles to the strike of the schists, or the line of contact of these with the granite, instead of being parallel to them. The actual granite contact has not been exposed, but a dioritic body has intervened between the granite and the schists. The line of contact between the schists and the diorite matter (locally known as the "blue rock") is well defined and unconformable with the bedding of the schists.

This dioritic body is very decomposed and at only one point in a deep adit has it shown some little hardness and a change of colour. No hand specimen has been procurable fresh enough to enable a slide to be cut out of it. A large face of this rock has been exposed in the sluicing cut, and from many samples taken, it shows the peculiarity of being tungsten-bearing. This has been found in almost every sample in quantities varying from traces up to 1½% of WO_3. On crushing, no wolfram concentrate was obtainable, but the wet assay almost invariably resulted in WO_3 being obtained. What this occurrence may lead to cannot yet be determined, but should an average high percentage of WO_3 be obtained over a wide range of samples, some method of treatment by crushing and leaching could no doubt be devised. Through the mineralized zone and the surrounding schists several minor reverse faults have been observed, which only slightly displace the lodes. The mineralized zone has been traced over the hills for a length of some 1,500 ft. and of a width of about 800 ft.

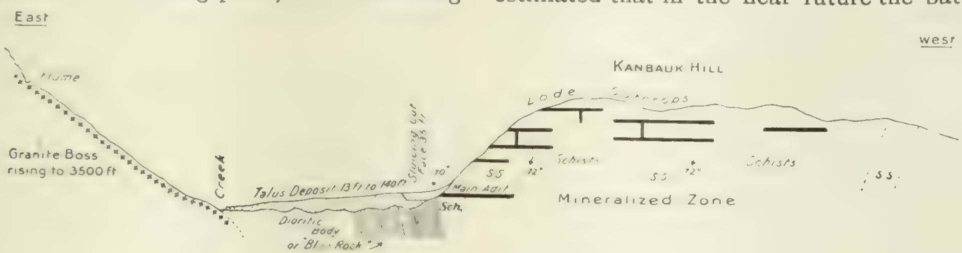
For details of the geology I may refer readers to my article published in the Magazine for June 1914, or to Dr. Bleeck's monograph in the Records of the Geological Survey of India, vol. xliii., part 1, 1913.

THE LODES.—In the mineralized zone some 20 outcrops of quartz carrying wolfram have been traced and prospected or mined in many places. Owing to the faults mentioned, and to the varying altitudes at which these outcrops have been opened out, it is probable that they do not all represent separate and distinct lodes, and that some outcrops may be only the continuation of others. It is therefore impossible, until connection has been made underground, to say exactly how many lodes exist on the property, but their number nevertheless is important. Most of them dip to the south, and a few to the north, and a few cross reefs have



PLAN OF KANBAUK MINES

also been encountered in depth. The lodes are all well defined, of fairly regular thickness, and vary from 3 to 24 inches with an average of about 10 in. The plan on page 212 shows the general features as well as the position and run of the lodes so far ascertained. Below is given a section from east to west of the property running in the same direction as the lodes. It will be noted that the mineralized zone apparently occurs only on the rising ground, and that on the eastern slope of that ground and extending as far as the granite there exists a talus of considerable thickness and extent which carries detrital wolfram in important quantities. Thus the resources of wolfram on the property are twofold. The lodes have been opened at shallow depths, and stoped out for a number of years. Previous to the installation of a crushing plant, all the crushing



Section E W across Property

was done by hand, such portions of the lodes only which carried wolfram in large quantities being treated, the remaining quartz being thrown out on the dumps. On completion of the crushing plant all the quartz mined, together with a large portion of the old dumps, was crushed, the only portions of the lodes left in the stopes being those showing absolute blanks, so that the original returns of over 3% from picked ore have not been maintained. For reasons that need not be enumerated, but which were unavoidable, the latest mill returns have shown poor values, which, however, it is safe to predict will not continue. From careful consideration of the work which has been done, the conclusions arrived at are that about two-thirds of the lodes carry remunerative values, one-third representing the blanks or unprofitable values, and that the average yield has been $1\frac{1}{2}$%, or 34 lb. of wolframite per ton.

The results obtained from the lode workings have been as follows:

Year	Tons	
1912	206·75	hand crushing
1913	254·75	
1914	86·75	battery crushing
1915	70·50	
1916	55·85	

The total returns of the company have been as follows:

	Mine Ore Tons	Sluicing Tons	Total Tons
1912	206·75	—	206·75
1913	254·75	—	254·75
1914	86·75	37·00	123·75
1915	70·50	101·75	172·25
1916	55·85	249·50	305·50
	674·60	388·25	1062·85

THE MILL.—The working of the mill has been greatly handicapped through want of necessary water during the dry seasons, and through fuel and power difficulties. With the new plant under consideration, these drawbacks will be completely eliminated, and it is estimated that in the near future the battery should yield some 350 tons of wolfram concentrate per annum.

The latest costs of working at the mine are: for mining and development 18s. 5d., and crushing and concentrating 3s. 10d., or a total per ton milled of 22s. 3d. Including general expenses, these costs should not exceed 26s. The battery consists of 10 stamps of 1,100 lb., dropping 8 in., and the aperture of the screen is $\frac{1}{4}$ in. There are four Wilfley tables of No. 5 and 6 types. The installation is driven by a 32 b.h.p. Hornsby-Akroyd engine, assisted by a 12 h.p. portable engine and boiler. In 1916 the crushing operations resulted as follows:

Hours run, 259·5 hours per month equal to 35·4% only.

Mine ore crushed, 6,075·6 tons.

Mullock crushed, 1,600·4 tons (value $\frac{1}{4}$%).

Total ore crushed, 7,676 tons.

Stamp duty, 5·8 tons.

Mill concentrates (58% of WO_3) 43·7 tons

Mill concentrates (70% „) 25·35 „

Hand picked „ (71% „) 8·02 „

Average return of mine ore, 19 lb. per ton.

Average assay of tailing, 7·1 lb. per ton (70% ore).

CONCENTRATION.—It is not intended to give full particulars of the concentration methods tried, as this will form the subject of a subsequent paper. No actual and successful precedent having been procurable, the best method had to be discovered, and toward that end many experiments were made. Difficulties due to sporadic running of the mill, shortage of water, etc., were encountered, and militated against the best results being obtained. The fact as shown by the above figures that the mill recovery is about 70% shows that an improvement is still possible, and the facts obtained during the intermittent running of the last two years will allow of a more efficient method being devised. The past work has established the fact that it is advisable to crush the ore very coarsely, so as to prevent the formation of an undue amount of slime, and that under very unfavourable conditions the Wilfley tables have given good results. A system of jigging followed by concentration on tables will probably henceforth be adopted, and by this means it is hoped the losses will be confined entirely to a much smaller percentage in the shape of slime. The tailing has proved to contain only fine ore and slime which could only be concentrated with difficulty and the quantity of which could only be ascertained by the wet method. The losses indicated comprised the WO_3 contained in tungsten ochre which occurs in appreciable quantities in the decomposed portions of the lodes, and which in any case could not be recovered in any concentrating plant. Taken altogether, therefore, the recovery cannot be described as having been a failure. A method of recovery from the tailing is also under consideration. It is worth noting that of late the mill concentrate has shown 10% of cassiterite, and a small percentage of bismuth. The latter is sorted out of the hand-picked ore. The concentrates are not separated before shipment, this being done in England, the purchasers paying market rates for any cassiterite present. Magnetic separation on a large scale is now undertaken in Tavoy, but has not yet reached a state of great perfection. This may be due to the general coarseness of the concentrates, and their being treated without sizing or fine crushing.

LODE DEVELOPMENT.—A thorough scheme of development in depth is now being undertaken on several of the most important lodes, and two adits, placed at the lowest point of the hill, are destined to open out the majority of the lodes. Development is practically confined to depth, the shallow workings being continued only in order to work out as much of the outcrops as possible. For this purpose, a couple of "3F" Temple-Ingersoll electric-air rock-drills are employed, and the result has so far been satisfactory, and their more extended use is probable. These drills are worked by air pulsations produced by an electrically driven pulsator, fixed on a movable carriage. They are $3\frac{5}{8}$ in. in diameter, striking about 450 blows per minute, and are capable of drilling a hole down to 10 ft. They require a motor output of only 3 h.p. An excellent description of this drill is to be found in "Compressed Air Practice" by Frank Richards 1913, published by the McGraw-Hill Book Company.

At one portion of the property, one of these drills has been in operation in a hard granite quarry. Owing to the great distance from the works, the electric motor has been replaced by a small petrol motor. This drill, worked by two coolies, is capable of drilling a vertical hole 8 ft. deep in 3 hours on a consumption of 1 gallon of petrol. The total cost of drilling on this work is as follows:

2 boys at 1 rupee 12 annas	= 3 rupees	8 annas
2 gallons of petrol	= 1 „	2 „
Sundries, drills, lubrication, etc.	= 1 „	4 „
Total	6 rupees for 16 ft. drilled.	

equal to 6·24 pence per foot.

Underground, in a drive 6 ft. 6 in. by 4 ft. 6 in. in fairly hard ground, one of these drills manned by 6 coolies working on three shifts is capable of an advance of 30 to 40 ft. per month. Difficulty is constantly being experienced in driving in fairly hard country, as the Chinese coolie does not appear to take kindly to that work. His preference for stoping is quite unaccountable, as the work in the stopes is generally more difficult, more awkward, and not more remunerative, and in this class of work he is capable, in spite of his crude methods, of accomplishing marvels. In this mine, there are many places where stopes 18 in. wide have been taken out, neatly and without waste, and the work has been so well done as to be equalled only by that done by the ancients on the narrow reefs of Rhodesia. If left alone in this work, however, he will take out such portions of the lodes only as show very good values, and can be readily hand-picked. Thanks to the numerous pillars thus left since the time the ore was hand-crushed, there still remains in the old stopes a quantity of ore which will be well worth taking out.

As was to be expected on a property with numerous outcrops, the work has been scattered over a wide area, and most of any development undertaken has been for the purpose of immediate stoping. The work has, however, given excellent indications as to the values of the different outcrops, and of late, the policy of concentrating development and exploitation on a few lodes has been followed. Due provision for active and extensive development has been made, and in the near future the crushing capacity will probably have to be increased. Two main adits capable of tapping all the lodes at the level of the valley are now being driven. The maximum amount of backs will be about 400 ft., and the adits will enable the property to be exploited for some years before shaft-sinking becomes necessary. It will thus be gathered that in the case of this property, proper development is not likely to be neglected.

THE ALLUVIAL DEPOSITS.—The talus extending over the valley from the eastern foot of the hills has been prospected by means of shafts sunk at regular intervals of $2\frac{1}{2}$ chains or less. The area proved exceeds 173 acres, and a conservative computation gives 8 million cubic yards capable of being worked at a profit. The values in wolfram vary considerably, as would be expected in that class of deposit, and start practically from the surface, so that it cannot be said that any barren overburden exists. As the talus extends away from the hill, the wolfram contents diminish, but are almost replaced by corresponding values in cassiterite, until the clearing is reached where only cassiterite is found. It has been computed that the average value in wolfram or cassiterite would be $1\frac{3}{4}$ lb. per cu. yd., although the extensive sluicing done during the last three years has yielded very much better results.

Great expense was incurred in the construction of a flume line to tap the rain waters in the adjoining hills to the east. This has enabled the company to use monitors and to accomplish the following amount of hydraulicking:

Year.	Cu. Yd.	lb. per yd.
1914	52,000	1·38
1915	80,000	2·59
1916	128,000	4·28
Total	362,000	3·31

It is worth noticing that the value indicated by the 50 pits and bores enclosed in the area of the above work was 1·78 lb. as against an actual return of 3·31 lb.

During the dry months, the sluices are cleaned up and the stuff is conveyed to a point where a little water may be available in the creek. There it is washed by means of a 2 in. nozzle supplied by a centrifugal pump. During actual sluicing operations, the top portions only of the sluices are periodically cleaned up. The ore obtained from this source is cleaned up to a value of 68·6% of WO_3. The tailing at the end of the sluice is lifted by means of hydraulic elevators, and deposited at such points of the valley where there exists no deposit of value.

The following details of the 1916 sluicing operations may prove interesting, and may show that, notwithstanding the writer's criticism of what is not being done in Lower Burma, and other even more drastic condemnation such as is contained in a paper on Wolframite Mining in Tavoy District, by E. Maxwell-Lefroy, published in Bulletin No. 155, December 1915, of the Institution of Mining and Metallurgy, work of importance has been accomplished:

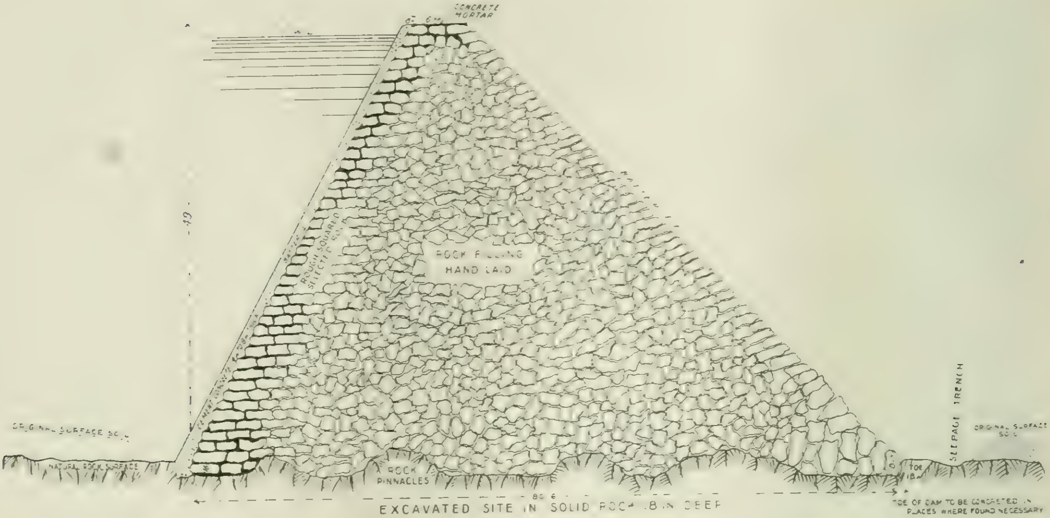
Period of Operations—June 8 to December 31, 1916.
Working hours: 4,560.
Monitors used: In June, 1, from $2\frac{1}{2}$ to 4 in.
In July, 3, from 2 to 4 in.
In August, 4, from $2\frac{1}{2}$ to 4 in.
In September, 4, from $2\frac{1}{2}$ to $3\frac{1}{2}$ in.
In October, 3, from $2\frac{1}{2}$ to 3 in.
In November, 2, from 2 to 3 in.
In December, from $1\frac{1}{2}$ to $2\frac{1}{2}$ in. (cleaning up).
Average pressure at nozzles: 125 lb.
Elevator: $2\frac{7}{8}$ nozzle from June 20 to November 30.
From July to November half the number of monitors stopped 86 hours each month in order to clean up sluices.
Labour employed, Chinese, distributed as in the following table:

Month	At Monitors	Raking in sluices and races	Picking and carrying stone	Looking after races, construction, etc.	Cleaning ore	Total
June	1	90	39	15	nil	145
July	2	120	58	25	nil	205
August	4	120	56	25	20	225
September	4	120	76	20	25	245
October	3	120	45	20	42	230
November	2	100	nil	nil	38	140
December	1	30	nil	nil	58	89

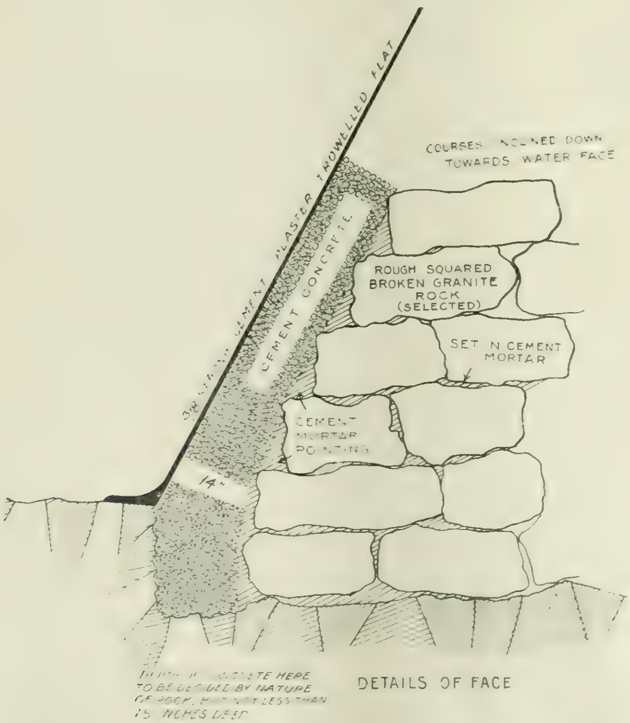
Labour employed in hand-sluicing and cleaning up from January 1 to June 7:

Excavating and carrying,		Chinese	43
,,	,,	Indians	39
Washing		Chinese	21
,,		Indians	6
		Total daily	109

Cubic yardage sluiced, 128,113.
Wolfram returns: 249 tons 13 cwt. 3 qrs. 21 lb.
Returns per cubic yard: 4·28 lb.



CROSS-SECTION OF DAM.



DETAILS OF FACE

Estimated realizable net value of output, £38,697.

Mine cost of producing 1 ton of wolfram, £27. 0. 0.

Toward the creek to the east, some deep pockets of alluvial have been shown to exist. As these are deeper down than the bed of the creek, their working will necessitate considerable elevation of the tailing. For this purpose a special installation, which will be detailed hereafter, has been designed and is now in course of erection, and by its means, sluicing operations will be possible throughout the rainy season, and a larger turnover will be attained.

The mine costs of sluicing are still high owing to the short period of work, and to the necessity of keeping the hand-sluicing going after the rains, and thereby keeping employed the labour which will be necessary for the following season. This hand-sluicing, consisting in excavating the lowest layers in the sluicing cut, cleaning up riffles, conveying the material to the water and washing it by hand, is of course very expensive, and brings up the working costs considerably. With the additional plant, hand-sluicing will be abolished, and it is calculated that the mine costs for hydraulicking will not exceed 8d., and that a ton of wolfram from this source on a return of only $1\frac{3}{4}$ lb. per cu. yd. and including all charges,

Cost of operations:	Wages Rs.	97,869
	Stores	1,086
	Upkeep, etc.	2,396
		101,351

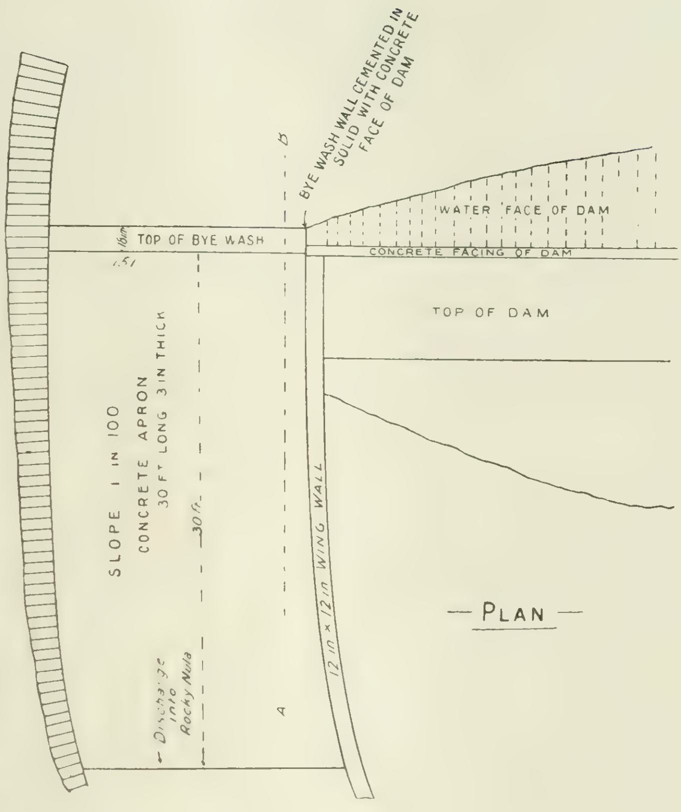
This includes all the costs of hand-sluicing, etc.

Cost per cubic yard, 12·6 pence (not including general charges).

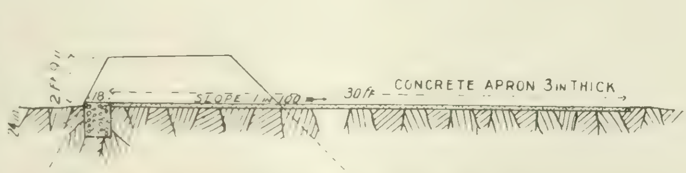
general, head office, freight, etc., will be produced at a cost of less than £33. Should in the meantime labour be less costly than at present, and it has a chance of becoming so, a further considerable reduction of costs will be possible. From these figures it is easy to calculate that the price of wolfram will have to come down to 9s. 6d. per unit before the work becomes unprofitable. In this connection, it is worth noting that, as far as can be ascertained, the average cost of producing wolfram, outside of Burma, would appear to be in the vicinity of £80 per ton.

Owing to the position of the property the cost of ore transport has so far been high, but as a good road now connects it with the river, and motor transport will become possible, the costs under that heading will be considerably reduced.

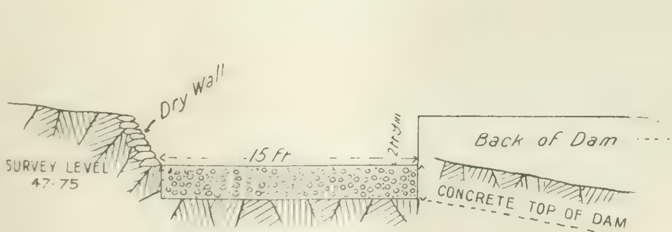
PROPOSED INSTALLATION.—The management has always realized the advantage that would be secured if rain water could be impounded in sufficient quantity to allow sluicing operations being carried on all the year round. After a large amount of exploration in the hills to the east of the property, a spot suitable for a dam of large capacity has been found, and a concession for the water has been obtained from the Government. By means of a dam about 600 ft. long and 45 ft. high, some 80 million cu. ft. of water will be impounded during the rainy season, without interference with the supply for present monitors, and will be drawn regularly during the dry months to supply a hydro-electric installation capable of working monitor pumps and sand pumps. The height of the impounding dam above the mine is over 2,000 ft.



— PLAN —



— CROSS SECTION A B —



— LONGITUDINAL SECTION —

The outline of the scheme may be described as follows: To store water in sufficient quantity to supply during the dry months, December to May, 182 days, a hydro-electric power plant of 450 b.h.p., the power to be used as follows:

14 in. nozzle pump	200 h.p.
12 in. gravel pump	180 h.p.
Mill, etc.............	70 h.p.

The effective height being 1,880 ft., provision for 3·9 cu. ft. per second has been made. The pipe line will be 15,000 ft. long, and will consist of 14 in. down to 11 in. steel pipes. As the dam has a larger capacity than is necessary, the piping has been made large enough to permit of an additional plant being erected when needed. The installation will be capable of dealing with 210,000 cu. yd. during the dry season, but owing to the enormous rainfall, and large catchment area, 1·35 square miles, it is probable the plant will be kept working continuously during the year. Particulars of the rainfall are given herewith.

RECORDED RAINFALL AT KANBAUK FOR 1915 AND 1916.

Month	Total for month		Max. fall for 24 hours		Dry days in each month	
	1915	1916	1915	1916	1915	1916
May	47·12	10·53	6·0	3·18	*	12
June	*	74·81	*	11·41	*	1
July	41·70	36·62	5·86	12·71	10	6
August	59·48	50·86	5·70	8·06	1	3
September .	21·39	35·84	3·18	7·33	7	4
October ...	28·68	9·97	5·85	1·79	12	16

* No statistics available.

IMPOUNDING DAM.—Owing to the difficulty of access to the site, and consequent high cost of transport of all material, a masonry or a concrete wall was considered out of the question, and for other considerations a rock-filled dam was decided upon. As this class of work is not largely employed, the details fixed upon are of some interest. As will be seen by the illustrations on pages 216 and 217 the maximum dimensions have been fixed as follows:

Slope of inner face (water)	$\frac{1}{2}$ to 1
Slope of outer face	1 to 1
Width at top	6 ft. 8 in.

Maximum width at bottom, 78 ft.

The inner face will consist of a stone wall set in cement mortar, and covered over, when settlement of the structure has ceased, by a concrete apron from 14 in. to 8 in. thick, faced over by cement plaster. As the wall is not designed to act as an overflow dam, a bye-wash, 140 ft. long and 3 ft. deep has been provided, which it is calculated will deal with the greatest recorded rainfall, without water reaching the top of the wall. The structure has been designed so as to have a factor of safety of nearly $2\frac{1}{2}$, which is greater than that of other similar structures which have stood for many years.

The following have been calculated:

Sliding force, base of dam,	28·2 tons.
Resistance (horizontal)	66·7 ,,
Factor of safety	2·35
Coefficient	0·70

Angle of repose of granite 60°; at this angle the coefficient of friction is 1·75. The force acting down the plane is 16·6 and the resistance to shearing 46 tons. This gives a factor of safety of 2·4. The site shows hard undecomposed granite in the creek with softer granite on the slopes. The latter has been excavated until a good solid toe has been obtained. The necessary granite for filling in is obtained from two adjoining quarries. As this work will be of some importance to miners it is intended to detail all its particulars in a special paper at a later date. In the meantime mention may be made of the fact that cement delivered on the spot is costing £10 per ton ($5\frac{1}{2}$ casks) and labour about 2s. per day. It is reckoned that the work will be completed well in time for the rains beginning at end of May 1918, and that by that time the new installation will commence work.

GENERATING STATION.—The power plant is to consist of: one turbine of the impulse type (Pelton wheel) arranged with single nozzle and horizontal shaft designed for a net head of 1,880 ft., working at a speed of 750 r.p.m., and capable of giving 540 b.h.p., the efficiency at full load being 85%. The speed regulation is to be obtained by a patent automatic oil-pressure governor capable of controlling, when the load is instantaneously thrown off or on, within the following limits:

25% inst. load change.	Max. speed variation not to exceed				2·5%
50 ,,	,,	,,		,,	4·5%
100 ,,	,,	,,		,,	12%

One 375 k.w. compound-wound commutating pole open type direct-current generator will be connected by flexible coupling to Pelton shaft, and arranged for 500 volts, 750 amperes, and 750 r.p.m.

The pumping plant to consist of: one 12 in. medium lift centrifugal pump capable of delivering 9 cu. ft. per second (3,400 gal. per min.) against a total head from all causes of 150 ft., running at 1,200 r.p.m. Delivery pipe 12 in.; this to be driven direct by a compound wound motor capable of developing 210 b.h.p. when running 1,000 to 1,500 revolutions from a 460 volt direct-current circuit. One patent gravel pump capable of elevating 75 cu. yd. of solid material per hour to a height of 60 ft., to be driven by a direct-coupled motor running 350 to 450 revolutions from a 460 volt direct-current circuit and developing 160 h.p. The balance of power generated to be used for driving electrically the 10 stamp mill, electric drills, etc. Ample allowance has been made in the size of the piping, and it is reckoned that another 150 h.p. may be available with a subsidiary generator during a portion of the year;

this will probably be utilized to drive a rock-drill installation, etc.

STAFF AND LABOUR.—The staff now is composed as follows: 1 manager, 1 assistant manager (mine manager), 1 miner, 1 engineer, 1 engineer and 1 assistant on construction work, 1 mine secretary and accountant, 1 assayer and surveyor, and 2 sluicing assistants.

The ruling rates of wages are as follows:

Surface labour, Chinese,	1 Rupee 12 annas	=2s. 4d. per day
.. .. Burman,	1 Rupee	=1s. 4d. per day
.. .. Indian,	Rs22 to 25 per month	
Miners—all work done on contract.		
Fitters	Rs55 to 75 per month	
Blacksmiths	Rs45	
Drivers	Rs35 to 40	

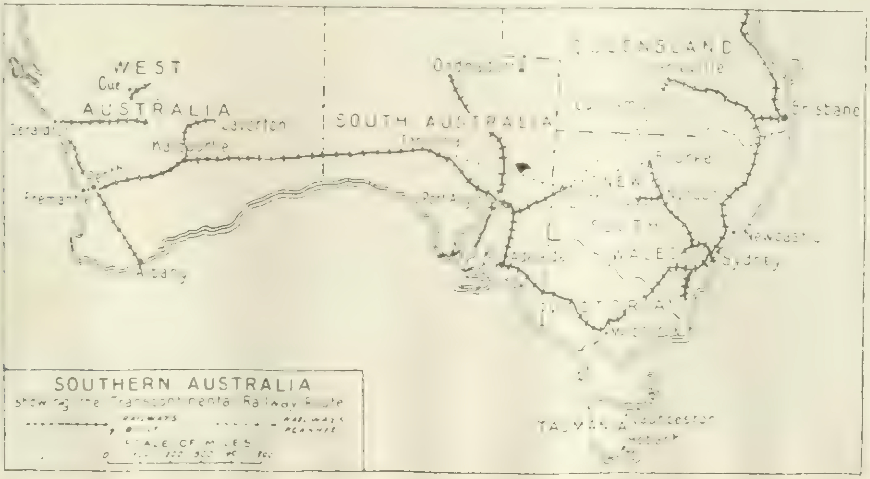
Average number of hands employed for the year, including miners, 361. 50% gelignite costs 1 rupee 10 annas per lb.; petrol 14 annas per gallon. Excavating and removing decomposed rock at dam, Rs2 per 100 cu. ft. Spalling stone for concrete, Rs8 per 100 cu. feet. Hammer boys on hard granite 12 annas per foot, maximum depth 4 ft. Cost of transport to dam, Rs60 per ton; maximum coolie load 50 lb.

CONCLUSION. — The above description, though short, will suffice to indicate what is contemplated at Kanbauk mine, and to show that the mine is being opened out and equipped on a substantial and permanent basis. When the new in stallation is fully completed, it is calculated that the mine should produce a yearly output as follows:

From the lodes	388 tons	
From the alluvial	242	(on 1·75 lb. yield only)
	630 tons	

Until the new plant is at work, however, the yield from the alluvial may be slightly in excess of that indicated, as work until then will be carried on ground which is known to be of higher value than the average, and the profit on which will go far to pay for the cost of the new plant. The battery is not expected to yield the above returns until it is supplied with the power contemplated, and the scheme of underground development now being carried out has progressed. The elements for a successful exploitation are present, and the difficulties in the shape of want of suitable labour, and other drawbacks, will be diminished or eliminated in the course of time.

Australian Transcontinental Railway. —This railway connecting Port Augusta and Kalgoorlie was opened for traffic on October 20. Port Augusta is at the head of Spencer Gulf in South Australia, and is distant 1,053 miles from Kalgoorlie. When construction of the railway was commenced, 800 miles of this was uninhabited desert. Water supply is scarce throughout the route, and it was necessary to excavate reservoirs for the purpose of impounding surface waters. Such reservoirs are situated 53, 94, 130, 190, and 250 miles from Port Augusta, and 69, 104, and 132 miles from Kalgoorlie. The gauge is 4 ft. $8\frac{1}{2}$ in. Unfortunately the gauge of the rails between Kalgoorlie and Perth, and between Port Augusta and Adelaide is 3 ft. 6 in. It had been intended to widen the West Australian line concurrently with the construction of the transcontinental railway, but the State funds did not permit of the expense. The time occupied on the journey between Kalgoorlie and Port Augusta will be 35 hours, though the road has been built to admit of a higher speed if necessary.



LATERITE:
ITS ORIGIN, STRUCTURE, AND MINERALS.

By J. MORROW CAMPBELL, B.Sc., M.Inst.M.M., F.R.G.S.

(Concluded from October issue, page 179).

In this, the final, instalment of the article, the author discusses the Minerals of Laterite, and Classification and Nomenclature; he also examines the views of Professor Lacroix relative to the Laterites of French Guinea and those of Dr. Falconer on Northern Nigerian Laterite.

Chapter IX.—The Minerals of Laterite.

(1) Ferric Hydrates and Oxide.—Before dealing with the various forms in which iron occurs in laterite it is advisable to place on record work that has been done on the composition of various ferric hydroxides both existing in nature and formed artificially.

The colloidal iron mineral separating when natural ferruginous solutions are oxidized is called ferric hydrate, but its composition is not known. When first formed it is brown in colour, but it rapidly turns red. It was considered necessary to investigate the composition of the hydrates of iron formed under various conditions and also the reason why the brown hydrate changes its colour to red. The literature dealing with ferric hydroxides does not give us satisfactory data. The recently published work by Fischer, in which the conclusion is reached that the only definite compound is goethite, and that the others are merely ferric oxide with a varying amount of water not chemically combined is not at all likely to be accepted by mineralogists.

The following ferric hydrates are generally accepted as existing in nature: (1) Turgite, $2\ Fe_2O_3, H_2O$; (2) Goethite, Fe_2O_3, H_2O; (3) Limonite, $2\ Fe_2O_3,\ 3\ H_2O$; (4) Xanthosiderite, $Fe_2O_3,\ 2\ H_2O$; (5) Limnite (?), $Fe_2O_3,\ 3\ H_2O$. The last is quoted by Dana as said to occur in an impure bog iron ore found in the vicinity of Nijni Novgorod; its existence seems, however, to be doubtful.

We must necessarily regard the so-called water as being combined weakly in the molecules as hydroxyl. The ferric oxide molecule must therefore contain at least 4 atoms of iron or a multiple of four. On this supposition all the possible ferric hydroxides would be:

$Fe_4O_6,\ H_2O$ ...$Fe_4O_5\ (OH)_2$......Turgite
$Fe_4O_6, 2\ H_2O$ ...$Fe_4O_4\ (OH)_4$......Goethite
$Fe_4O_6, 3\ H_2O$ ...$Fe_4O_3\ (OH)_6$......Limonite
$Fe_4O_6, 4\ H_2O$ ...$Fe_4O_2\ (OH)_8$......Xanthosiderite
$Fe_4O_6 \cdot 5\ H_2O$ ...$Fe_4O(OH)_{10}$ ......(Unknown)
$Fe_4O_6, 6\ H_2O$ ...$Fe_4(OH)_{12}$ ....? Limnite

The similarity between the affinities of ferric iron and aluminium would lead us to expect that a ferric hydrate in which the whole of the available affinities were satisfied by hydroxyl should be capable of existing, that it would form only at low temperatures, and be readily decomposed by heat.

The writer some years ago examined Mossgruben, a pyrite mine near Ranen Fjord in Norway. In this and other mines in the vicinity the outcrop is covered by an iron cap. As the Mossgruben pyrite is almost chemically pure iron disulphide, the iron cap is of unusual purity. The mineral composing it occurs in fanciful forms, which are frequently frail and very pretty. Specimens were taken, one of which is at present in the Natural History Museum, South Kensington. When this question of ferric hydrates arose this mineral was examined. The air-dried material yielded under 2% silica as its only impurity and contains 26 to 27% water. This corresponds well enough with the formula $Fe_4(OH)_{12}$, which demands 25·29%. Prolonged air-drying did not reduce the water below 26%. Samples were treated for weeks in a water-oven just below 100°C and no loss was sustained after the first 48 hours. The loss on heating this to redness was just over 22%. This substance corresponding to the formula $Fe_4O(OH)_{10}$ is stable at 100°C. Its stability and composition lead me to believe it is the missing member of the above series of ferric hydroxides. If this is correct we cannot doubt that the original mineral is also the definite compound $Fe_4(OH)_{12}$, the highest possible hydroxide. Further heating for two weeks at 110 to 115°C resulted in driving off about 4% water, the residue corresponding in composition to xanthosiderite. Subjected to increased temperatures ranging up to 200°C gradual desiccation resulted without further indication of the arrest of the process at definite points corresponding with the expulsion of water in molecular quantities.

The fact that the properties of this limnite differ from the artificially prepared highest ferric hydroxide in much the same way as gibbsite differs from the same hydroxide artificially prepared, combined with the fact that limnite as formed at Mossgruben comes into existence under exactly the conditions which should favour its production, if capable of existing at all, strongly support the claim that this is a definite compound.

It occurs as an incrustation, in stalactitic, stalagmitic, and botryoidal forms. It is homogeneous in structure, brownish-black in colour on a fractured surface and ochre-yellow outside. Fracture conchoidal. Very brittle. Hardness, 3. Specific gravity 2·7 to 3·0. Streak ochre-yellow. It is readily soluble in cold dilute hydrochloric acid, and also dissolved by cold dilute acetic acid. After prolonged heating at 100°C it also dissolves readily in cold dilute acetic acid.

If a solution of ferric chloride is decomposed by ammonium hydrate we get a copious precipitate of ferric hydrate. Various authorities state this to have the composition Fe_2O_3, $2\ H_2O$, similar to xanthosiderite, and Gmelin asserts that it has this composition precipitated either hot or cold. Ferric hydrate precipitated by an alkali from ferric chloride and dried at 100°C is said to have the composition $2\ Fe_2O_3$, H_2O (like turgite). Precipitated hot from ferric chloride and dried over sulphuric acid its composition is said to be $2\ Fe_2O_3$, $3\ H_2O$ (like limonite).

A solution of pure ferric chloride was prepared, cooled to 0°C, and kept at that temperature with excess of ice floating in it. It was rendered alkaline by the slow addition of ammonium hydrate also at 0°C. A copious dark brown precipitate was formed which settled quickly and completely, but was very bulky. This was washed repeatedly by decantation, filtered, the hydrate dried first by bibulous paper, then for several weeks in air at 60 to 75°F. After this treatment it was black in colour, hard and broke with a conchoidal fracture. No condition or duration of air-drying at the above temperature reduced its water content below 25·0%. When finely powdered and exposed to the air it absorbs an amount of moisture varying with the hygrometric conditions. Over sulphuric acid it undergoes gradual diminution in weight until it contains less water than limonite. Exposed for weeks to 100°C its weight becomes constant when it contains just over 10% water, corresponding in composition with goethite Fe_2O_3, H_2O or $Fe_4O_4(OH)_4$. Heated for a week from 100° rising to 130° it still yielded 7·3% water. At 170° it finally showed 5·5% water, nearly corresponding to the formula $2\ Fe_2O_3$, H_2O. The process was one of gradual desiccation. In every condition of hydration the substance is black, and after heating to redness it is glossy jet black. When hydrated its streak is brown even when approximating to the composition of turgite. Anhydrous, its streak is dull red.

Pure ferric chloride solution was next rendered alkaline with ammonium hydrate at boiling temperature. The hydrate precipitated was much paler in colour and less bulky than that precipitated in the cold; it settled more quickly but not so completely as the cold. It was washed and air-dried under exactly the same conditions as the cold hydrate. Its appearance was very different, being brown in colour, much softer, and more friable. Its qualities vary greatly under variations in concentration and temperature. Its water in air-dried condition varied from 19·2 to 22·2%, that containing most water being lightest in colour. Dried over sulphuric acid it gave up its water more slowly than the cold hydrate, and even after several weeks its composition does not approximate to that of limonite. Heating for over two weeks at 100°C reduced the water content to 10·30% (goethite contains 10·14% H_2O), and at higher temperatures it acts similarly to the cold hydrate.

The physical properties of the hot-precipitated hydrate differ greatly from those of the cold. It varies in colour through various shades of brown but is never black. In no matter what state of hydration, it is never hard and does not show a bright conchoidal fracture. The oxide resulting from heating it to redness is quite friable and is bright red in colour. As regards solubility in acids the cold hydrate is very much more readily dissolved at every stage, even the jet black ferric oxide which it yields at a red heat dissolving in strong hydrochloric acid in less than half the time required by that from hot-precipitated hydrate.

It seems evident that the ferric hydrates obtained at 0° and 100°C are different compounds since they differ so greatly in physical appearance, in their behaviour when heated, and also in solubility. The cold precipitated hydrate corresponds with the formula $Fe_4(OH)_{12}$, is quite uniform in composition, and dries in air to a homogeneous black mass with considerable hardness and conchoidal fracture, which must be assumed to be a definite compound. In some respects it resembles limnite. The wet ferric hydrate precipitated in the cold was left under water for six months, when it changed in colour from dark brown to ochre yellow. This I believe to be the composition of the ferruginous material which gives a yellow colour to clays. This air-dried yielded nearly 26% water at red heat. After exposure over sulphuric acid for ten days it yielded about 12% water at red heat. I believe that the highest ferric hydrate exists in nature as above described, and that this mineral when heated to 100°C loses a molecule of water yielding $2F_2O_3$, $5H_2O$ or $Fe_4O(OH)_{10}$. Attempts to prepare the latter artificially failed, but there seems little doubt that ferric hydrate precipitated in the cold is in the highest possible state of hydration $Fe_4(OH)_{12}$.

Péau de Saint-Gilles[47] asserts that when ferric hydrate precipitated from ferric chloride is boiled 7 to 8 hours it changes colour from brown to red, and is practically insoluble in strong hydrochloric or nitric acid, but soluble in these acids diluted or in dilute acetic acid, giving a red solution from which a red hydrate is precipitated on addition of strong hydrochloric or nitric acid or a trace of an alkaline sulphate. This hydrate does not, when dissolved in dilute acid, respond to the ferro-cyanide or sulphocyanide tests for ferric iron. A repetition of this experiment was attempted, using pure ferric hydrates precipitated at 0°C and at 100°C, washed thoroughly to remove ammonium chloride. Boiling in pure water for 8 hours had no appreciable effect on either of these hydrates. Next two lots of ferric chloride were taken, one strong and one weak solution, both rendered alkaline at ordinary temperature with ammonium hydrate, and boiled for 8 hours. The precipitate from the weak solution undoubtedly turned red; it would not settle even after standing for many hours, and passed freely through filter-paper. Its chemical properties did not correspond with those stated above. It appears to be a mixture of different hydrates, indicating that some change was in progress in boiling but that it was incomplete. The strong solution turned red (both liquid and solid), and on cooling fine orange crystals resembling bichromate of potash in colour separated out. They were sparingly soluble in water, not hygroscopic, and contained only about 1% iron on analysis.

Since iron ores and the iron in laterite separate out in a medium always saturated with water, it was considered that ferric hydrate might be dehydrated more readily under the influence of heat when wet than when dry, and experiments were conducted in order to determine this.

There is now no doubt that ferric oxide in the anhydrous condition is produced in some way from ferric hydrate under the conditions in which laterite forms, and that it is not produced by any natural process near the surface in temperate climates. In cold climates we have already seen that ferric oxide is capable of combining to its full capacity with hydroxyl, and that the compound is perfectly stable in dry air and even over sulphuric acid, in which respect it differs from the artificially prepared highest ferric hydrate. In other words the influence of time tends to strengthen the combination of ferric iron and hydroxyl at temperatures below about 30°C and in the presence of water. Above this temperature does ferric iron tend to throw off hydroxyl and combine with oxygen only? The phenomena presented by laterization suggest this, but the element of time must also be taken into consideration as in the formation of limnite. The experiment of Péau de Saint-Gilles seemed at first to discourage this idea.

Ferric hydrate precipitated cold (as it is in laterite) and washed, did not alter in appearance after boiling for 8 hours. It yielded when air-dried 18·4% water. That precipitated at 0°C treated similarly and air-dried yielded 23·6% water. Boiling ferric-hydrate 8 hours in the presence of ammonium chloride caused it to turn red, but it did not correspond either in hydration or in chemical properties with that of the author quoted.

Pure ferric chloride solution rendered alkaline with ammonia at ordinary temperature was boiled for 24 hours. The precipitate, brown of first, turned bright red, and was so fine that it passed freely through filter-paper. In water it only partly settled in a week. When air-dried this red powder yielded on ignition 3·14% water, and it did not glow at a red heat as does ordinary ferric hydrate.

Ferric hydrate precipitated in the cold and thoroughly washed was boiled in a dilute solution of ammonium chloride for 75 hours, washed, air-dried, and heated to redness did not glow and yielded 2·28% water. As it was possible that the fact of ammonium chloride boiling at a slightly higher temperature than pure water might explain the desiccation, pure ferric hydrate was boiled in a solution of common salt, boiling at a temperature higher than the ammonium chloride. After a week's continuous boiling the colour was still brown, and although undoubtedly undergoing desiccation the iron was still highly hydrated. Similar ferric hydrate was then boiled in distilled water; in 7 days the colour was appreciably redder, decidedly so in 10 days, and a dirty brick red in 15 days. After 25 days' continuous boiling it was allowed to cool and settle. Some solid matter settled in a few days, but after a month the liquid was not transparent, and still held

[47] *Ann. Ch. Phys.* [3] xlvi. 47.

much colloidal red ferric oxide in suspension. The first sediment after air-drying yielded 3·45% water, and later sediments slightly less. These do not glow at a red heat. It is evident therefore that ferric hydrate heated in the presence of ammonium chloride is rapidly converted into ferric oxide, similar in form to the modification left after ordinary oxide has glowed, that is the form difficultly soluble in acids. Ferric hydrate heated for a prolonged period (weeks) in pure water gradually yields the same form of ferric oxide in colloidal condition, but the presence of sodium chloride in the water either greatly retards or prevents the change.

It is remarkable that if two portions of pure ferric hydrate precipitated at ordinary temperatures are subjected to a temperature of 100°C, one dry and the other in water, the former yields as its ultimate product a compound corresponding to the formula Fe_2O_3, H_2O or $Fe_4O_4(OH)_4$ similar to goethite, whereas the latter yields anhydrous ferric oxide in a form which can be obtained only by means of dry heat amounting to about 600°C.

At low temperatures the ultimate result of the action of water on ferric hydrate is that all its available affinities are satisfied by hydroxyl producing the mineral limnite $Fe_4(OH)_{12}$. At 100°C the ultimate result of the action of water on ferric hydrate appears to be the total expulsion of hydroxyl; all the available affinities being satisfied by oxygen, and anhydrous ferric oxide results. The determination of the critical temperature or temperature above which ferric oxide results and below which full hydration takes place, is to be the subject of further research. Investigation of the conditions under which goethite forms will follow. In the change of limonite to turgite, which is often seen on the outside of limonite nodules, gradual desiccation does not take place, but molecular rearrangement for the intermediate hydrate goethite has never been observed to occur.

Many of the red earthy iron oxides occurring in nature and used as pigments contain under 3% of water in combination with the iron oxide. This is not driven off at 100°C. In many ways these closely resemble the product of the prolonged heating of ferric hydrate in water. So constant is this combined water at 2 to 3% that we are forced to suspect that after all we may have a mixture of turgite and oxide in place of anhydrous oxide alone. This remains to be ascertained.

The red colour of powdered laterite, which is so frequent, demands that in such cases the predominant iron mineral present has a red streak. Turgite and anhydrous ferric oxide are the only two such. The simultaneous presence of any other ferric hydroxide of higher hydration (all of which have brownish streaks) in considerable quantity would make itself evident in a colder tone. The bulk of the iron in the majority of laterites is therefore either anhydrous or in the form of turgite. The writer believes that the experiments on the heating of ferric hydrate in water explain why this is. The precipitation of iron from ferruginous solutions at temperatures at which laterite forms does not produce either of these compounds direct; their formation is due to the combined action of water and heat. In the absence of water the red iron minerals do not form except at high temperatures. Take for example the skin of laterite. This usually is composed largely of limonite because it is dried shortly after deposition and is not exposed *continuously* for a long period to the combined action of water and heat, but alternately dried and wetted. Heat alone is inadequate, for the skin of laterite is certainly raised to a higher temperature than the material underlying it, yet the latter contains anhydrous ferric oxide—the skin never—though it is believed sometimes to contain turgite.

The exact condition of hydration of the colloidal ferric hydroxide at the moment of its precipitation in laterite is not known and would be very difficult to determine. It is not of great importance, however, for we know that it does not remain long in that condition. In its next stage it is admixed (or combined) with aluminium hydrate. Its condition here also is not definitely known, therefore we have to admit that we do not know in what condition of hydration iron minerals primarily separate in laterite. Coming to the minerals resulting from secondary action we have more definite information. A crystalline ferric hydrate often lines passages and cracks. Its colour is orange to bright red by ordinary transmitted light, strongly pleochroic, bright yellow to reddish-brown. It shows fibrous structure perpendicular to the surface on which it was deposited but no definite crystalline form. Hardness not over 3.

Prof. Lacroix considers this mineral to be limonite, but the hardness of limonite in its amorphous condition is 5 to 5·5, and we cannot expect a mineral to have in its crystalline condition a hardness lower than that in its amorphous state. It has not been found possible to collect enough of the crystals to make a determination of the water in them. Indications point to it being xanthosiderite Fe_2O_3, $2\,H_2O$.

Its hardness and ready solubility in hydrochloric acid prove it to be neither limonite nor goethite.

Another red ferric hydrate, of secondary origin and considerably harder, is also found in certain laterites. It often occurs in spherules of radio-crystalline structure. It resembles goethite, and may be either that or crystalline limonite. Limonite, as previously stated occurs in the skin of laterite, also lining passages near the surface; it is only very rarely pure, being mixed ordinarily with varying proportions of aluminous minerals.

Anhydrous ferric oxide certainly exists in laterite; usually it is a secondary product resulting from the simultaneous segregation of iron and alumina in mixtures of their amorphous hydroxides. Turgite is believed to occur also as a secondary product, but it is extremely difficult to differentiate this from the anhydrous oxide.

(2) ALUMINIUM HYDROXIDES.—There is every reason to believe that alumina in the initial stages of laterization is deposited exclusively in the form of the amorphous tri-hydrate $Al_2O_3, 3H_2O$ or $Al_2(OH)_6$. When approaching a state of purity this is a soft wax-like solid with conchoidal fracture. It has been observed nearly pure in certain bauxitic laterites from the Guianas. In these it has been converted largely into white earthy bauxite. There is no possible doubt that dehydration has taken place, the bauxite-filled passages ramifying in all directions through the waxy mass. It requires an infinity of patience to separate the two and obtain sufficient of them to allow of determinations of water being made. Four determinations of water in the waxy tri-hydrate were all between 33·5 and 34·0%; the pure tri-hydrate demands 34·6%. The white earthy bauxite is more difficult to obtain pure; four analyses of it varied from 26·02 to 26·92% water. Pure bauxite demands 26 per cent.

In old Ashanti pisolitic laterites there sometimes occurs as a secondary product a milk white, soft, opaque variety of aluminium hydrate which yields about 16% water on analysis. This appears to be the amorphous mono-hydrate which in a state of purity contains theoretically 15% water. The occurrence of diaspore, the crystalline mono-hydrate, has never been observed in laterite, and it is difficult to believe it could be formed as the result of laterization.

The only crystalline form in which alumina has been observed is the tri-hydrate, and this exists in variable quantity in practically every old laterite. It seems to originate in two separate and distinct ways: (1) as the result of segregation within an amorphous matrix composed of ferric and aluminium hydrates; (2) as a deposit (lining passages and cavities) from vadose water in the laterizing zone. It is believed to be the result of the spontaneous decomposition of alkaline aluminate solution.

Prof. Lacroix[48] says that aluminium hydrate behaves like a soluble substance, more especially with reference to the formation of gibbsite. Prof. Harrison[49] says alumina under conditions of laterization is capable of entering into solution, transference from place to place and re-deposition in the form of aluminium hydrate where conditions are favourable.

The optical properties of gibbsite from various parts of Africa, India, and South America are indentical; the figure for birefringence is about 0·011, much lower than the Norwegian mineral, and its refractive index higher, about 1·57. Well-formed crystals are rare, polysynthetic twinning very common.

The structure of laterite, when studied with the microscope, proves positively that aluminium hydrate is deposited from aqueous solutions in both the amorphous and crystalline forms, and it is believed to be primarily in the form of tri-hydrate in all cases except when along with ferric hydrate with which it may be combined.

(3). HYDROUS SILICATES OF ALUMINA.—Vadose water holds both alumina and silica in solution, and there are many reasons for believing that under favourable conditions silicate of alumina results from their combination. It is difficult to believe that so-called kaolin is invariably an insoluble residue resulting directly from the leaching of felspars and other double silicates in the zone of permanent saturation. The only author who (to the writer's knowledge) refers to the natural synthesis of hydrous silicate of alumina is Mr. E. A. Simpson[50]. In a paper dealing with laterite in Western Australia he says that alumina and silica are deposited together from aqueous solution as colloidal halloysite while excess of alumina is precipitated as gibbsite.

Every sample of laterizing water examined by the writer deposits some hydrous silicate of alumina along with lateritic constituents on oxidation, and it is difficult to believe that it can originate in any other way than by the combination of alkaline aluminate and alkaline silicate. The factor determining its deposition

[48] Op. Cit., pp. 278 & 340.
[49] *Geol. Mag.*, 1910, p. 454.
[50] *Geol. Mag.*, 1912, p. 403.

seems to be the liberation of carbonic acid from combination with ferrous iron when the latter is oxidized by atmospheric oxygen. Certain Nigerian waters deposit hydrous silicate of alumina only; this is perhaps more difficult to explain. The intimate mixture of clayey material with concretionary limonite, the association of similar material with free alumina and colloidal ferric oxide in various earthy deposits (especially American) used as pigments and the frequency with which hydrous silicates of alumina are found in concretionary form or lining passages are all difficult to explain unless we admit their natural synthesis from alumina and silica in solution in vadose water. Observation has persuaded me that much of the kaolin of laterite comes into existence in this way. It may even form quite freely in the zone of permanent saturation in all countries, but it seems certainly to come into existence in the zone of intermittent saturation under laterizing conditions.

Regarding the nature of the hydrated silicate of alumina occurring in laterite, research has given little satisfaction on account of the difficulty of obtaining material in a state of sufficient purity to permit of its being investigated. The microscope reveals the presence of kaolinite (Al_2O_3, 2 SiO_2, 2 H_2O) in very small crystals but only in subordinate quantity; the bulk of such material is amorphous. Halloysite is given the same formula as kaolin, but the pure mineral usually yields nearlv 20% water; moreover, it is decomposed by hydrochloric acid, whereas kaolinite is not. In investigating the matter my experience agrees exactly with that of Prof. Lacrox[51] in that only traces of silicate of alumina are dissolved by strong hydrochloric acid. Allophane I have never found. If halloysite is decomposed by hydrochloric acid it certainly does not exist in any laterite I have examined. The amount of water yielded by laterite is very seldom sufficient to permit of the existence in it of halloysite in any quantity. Mr. E. A. Simpson has had a different experience in Western Australia; he asserts positively that the silica of the clayey minerals is liberated by strong hydrochloric acid, and regards the compound as secondary colloidal halloysite. The problem will be investigated further.

(4). TITANIUM MINERALS.—These minerals are usually not to be seen in laterite even when analysis proves that over 10% of it consists of titanium oxide. Chemical analysis gives us very little assistance, and the microscope appears to be useless. Titanium in laterite has neither the economic importance nor the scientific interest that attaches to iron and alumina minerals.

[51] Op. Cit., p. 3?3.

CHAPTER X. CLASSIFICATION AND NOMENCLATURE.

I fully realize that the student whose main interest in laterite is the solution of the problem of its origin may find it difficult to place himself in the position of the geologist whose duties involve mapping and the systematic naming of the various rocks encountered especially on the surface. To the latter the names laterite and lateritoid are useful since they are of service to him in his work, but the former is liable to lose patience with a system which gives a different name to a rock when it contains over or under an arbitrarily fixed percentage of certain compounds. This system is similar to that by which igneous rocks are grouped according to their silica content. It does not follow, however, that analogous systems of classification for rocks so very different, as laterite and igneous rocks, should be equally satisfactory for both.

The most important consideration is that laterization be understood and that rocks really containing lateritic constituents should be given a name indicating such and not be called by such names as surface ironstones.

To make the name of a lateritic rock depend upon whether it has derived its lateritic material from the mother rock itself or from extraneous sources seems to me meaningless, since I am convinced that no laterite in existence, whether highly ferruginous or aluminous, derived any but a negligible amount of its hydrates from the actual portion of rock the place of which it occupies. There are plenty of lateritic deposits which cannot be classed genetically either on their composition or structure; it is impossible to say whether they are of detrital origin or not unless one sees what lies below them; if this is detrital the laterite is detrital. If a decomposed crystalline rock lies below, the laterite may be partly or wholly non-detrital. The upper portion of almost all laterites is the result of laterization of transported material, and if this does not contain components characteristically detrital and also insoluble and unlaterizable the boundary between that of detrital origin and that derived from rock *in situ* cannot be traced. If the thickness of laterite deposits was great this point would be unworthy of consideration, for the detrital portion above would usually be insignificant compared to the non-detrital, but we must accept things as they are. Most lateritic deposits are under 20 ft. in thickness usually detrital above, and where non-detrital below, in the case of schists, granite and gneiss, the ratio between the amount of the two types cannot usually be determined.

In a very large number of cases the geologist must determine in the field, if possible, whether a specimen he takes is of detrital origin or not; away from its surroundings there is often no possible means of classifying it. There are igneous rocks whose composition places them on the border-line between classes; in the case of laterite the number that lie on the border-line is so large that the meaning of the word "laterite," for example, used in either the sense in which Dr. Fermor or Prof. Lacroix applies it, becomes of very questionable value. Classification on the basis of mineralogical composition is evidently the most rational and I certainly favour Prof. Lacroix's system of using the word laterite with a suitable qualifying adjective for what he calls "*laterites proprement dites*" or those in which the process has run a full course, and using the name properly applicable to the rock before laterization started, qualifying it with the word lateritic, for younger deposits. If such a system of classification were to be adopted it is obviously irrational to exclude from the former class such laterites as contain much primary quartz when genetically they belong to that class. I should have no hesitation in classing such as Prof. Lacroix does "*sur les eléments néogènes*."

The word bauxite has now been appropriated in commerce where it means aluminium ore, the value of which depends upon the amount of uncombined alumina it contains whether that be crystalline (gibbsite) or amorphous. It seems absurd that a rock consisting at times almost entirely of crystalline tri-hydrate should go under the name originally applied to the amorphous di-hydrate, but it would be futile to attempt to alter what custom has decreed. The mineral bauxite has had a chequered career; first everyone apparently accepted it, next almost everyone either doubted or disbelieved in the existence of a definite amorphous mineral corresponding in composition to the formula Al_2O_3, $2\,H_2O$. The writer is now sure it does exist, and is produced by dehydration from the amorphous tri-hydrate. This will ultimately be quite established but we shall probably continue to call it bauxite in conformity with the usual English lack of system in nomenclature. Whatever happens, however, we cannot regard laterite and bauxite as synonymous terms; the former must remain the family name, the latter being an aluminous variety usually the result of removal of iron from ordinary laterite, or the name of a definite hydrate of alumina, or both.

To base either nomenclature or classification on supposed metasomatic origin must necessarily fail. Usually the whole of the iron has been removed from rock before laterization commences, so *all* the iron of laterite is introduced from outside. The hydrous silicate of alumina upon which the process commences operations is apparently entirely dissolved during its progress. If any of this dissolved alumina should be deposited in the position from which it was removed in solution, it can only be accidental, for the structure of laterite indicates clearly and unmistakably that it is the result of a prolonged series of alternations of conditions, successive periods of dissolution (of hydrous silicate of alumina and lateritic constituents) and deposition. The process by which a passage, often several millimetres in diameter, is dissolved in a rock and then filled again completely, as laterization has been demonstrated to do, certainly is not in any way metasomatic.

Chapter XI. The Laterites of French Guinea.

These particular laterites are referred to because the writer spent 18 months in the same districts to which Prof. Lacroix subsequently paid a visit. It is the intention to bring into prominence points which support the writer's arguments and those on which his deductions differ from those of Prof. Lacroix. The professor's protest against the practice of calling laterized alluvium by the name ferruginous conglomerate applies to Nigeria as much as to French Guinea.

On p. 276 of his work reference is made to the direct formation of gibbsite from felspar; this is now practically proved to be impossible. Even if the whole of the alumina of a felspar crystal were converted into gibbsite *in situ* there would still be a large vacant space. It is true that such spaces are not always filled, but very frequently they are, in which case it is evident alumina must be brought in from outside. As a matter of fact it is all brought in. Regarding the position of the gibbsite crystals we find: "mais dans aucun cas je n'ai vu d'orientation du produit néogène sur son hôte."

Page 281. The disparity noted here in the products derived from nepheline syenite is readily explained. Bauxitic clays are the result of leaching of iron from semi-laterized layers. Above these are found highly gibbsitic laterites which arise through the dissolving of original amorphous hydrate of alumina and its re-deposition in the crystalline condition.

P. 287, dealing with laterite derived from diabase, this rock when high in iron is said to yield a highly ferruginous laterite, yet "dans les regions superieures la separation du fer et d l'alumine est plus complète et l'on peut recueillir des blocs formés à peu près exclusivement les uns par de l'hydrargillite et les autres par de la limonite." If the transformation is metasomatic and there is any correspondence between the original mineral contents of the diabase and that of the resultant laterite, how can this surface phenomenon possibly come about? If a ferruginous diabase yields even part of its laterite as highly aluminous it is obvious that the whole theory of ratios of various minerals corresponding in the mother rock and its laterite breaks down.

P. 288, still dealing with diabase, "observations * * * * qui montrent que les fissures et les cavités de la zone de depart peuvent être le siège de phenomènes identiques à ceux qui caractérisent la cuirasse exterièure." It is admitted that these could arise in no other way but by deposition of hydrates from circulating water. If the whole of laterization were admitted to be the result of the action of such water all these phenomena, otherwise puzzling, are simply explained. It is very extraordinary to find the admission that *deposition* can take place in the leaching zone. This confusion is the inevitable result of dealing with the process of laterization in reference to a *zone de depart* instead of water-level. P. 308 records a case of hard well-laterized schist with ferric hydrate deposited along the schistosity. Unless we admit deposition of iron from solution this is quite inexplicable. On p. 310 is cited a case of ferruginous pisolites in white cement and *vice versa* (the latter is unusual). The white is secondary, which does not seem to have been recognized. The gibbsite present in this is secondary also, whereas Prof. Lacroix regards it as the result of segregation like the same mineral within the pisolites; it obviously has been deposited from aqueous solution.

P. 313. The probability of the existence of an amorphous aluminium hydrate with one molecule of water is indicated. The writer isolated this and proved it to be the monohydrate. P. 317. A coarse pisolitic laterite from the Niger River on the Dahomey frontier is mentioned. Its pisolites are often hollow and cracked; it is bauxitic in composition. The cause of this is not recognized. Iron has been leached; this accounts for the interior cavities as well as the aluminous residue. The same phenomena are seen in the pisolitic bauxites of Tennessee. The suggestion that such deposits, including the bauxites of the Midi (France), are "latérites d'argiles" could not be admitted unless such aluminous deposits can be shown actually in course of formation now. On p. 322 we find "Il semble donc—et cela a, je pense, une importance theorique—que la consolidation de ces alluvions est due à la concretion de fer venant en solution à la surface par capillarité et s'oxydant au contact de l'air." This is in reference to the mode of origin of old detrital laterites concerning which on the previous page it is noted that "les sondages ont mis en évidence au-dessous de cette roche dure des argiles et des alluvions non-consolidées." If this is the mode of consolidation and laterization of detrital material, as appears to be admitted, it is difficult to understand why it is not recognized that material derived from rock *in situ* which is subjected to the same influences must be laterized in the same manner.

On p. 341 it is stated that gibbsite crystals are formed both from aqueous solution and by transformation of the amorphous variety; also that the latter, it is considered to have been demonstrated, gradually takes the place of hydrous silicate of alumina in laterite. This is practically in exact accord with the writer's observations. On p. 342 Prof. Lacroix supports my remark that in Africa the conditions necessary for the deposition of Dr. Fermor's lake laterites have not been observed. P. 343. Conditions of separation of colloidal and crystalline hydrate of alumina; the contention is that the amorphous form separates first and continues to be deposited till crystallization sets in, when the tendency is for the whole of the hydrate to be converted into gibbsite. The writer has observed cases in which the colloidal form has certainly been deposited as an interior lining in passages previously surrounded by a layer of gibbsite crystals. The conditions determining which form separates do not appear to be known, for gibbsite is not invariably, though usually, the last to form.

The writer is largely in agreement with Prof. Lacroix's opinions on the alteration of rocks in the tropics as compared with that in cooler regions, but regards the opinion that the search for the cause of laterization outside the laboratory is futile to be somewhat hasty. Toward the end the connection between vadose water-level and laterization seems to be almost realized. It is only by appreciation of the connection above mentioned that the method by which the process works can be understood.

CHAPTER XII. NOTES ON NORTHERN NIGERIAN LATERITE.

Dr. Falconer in his "Geology and Geography of Northern Nigeria," a work which has enjoyed a considerable circulation, has expressed certain opinions on laterization in general and practically denies the existence of laterites in that colony. It is almost impossible to believe that the samples, which he must have collected, were analysed before these opinions were expressed. Not only laterite but bauxite of good quality is found in Northern Nigeria.

On p. 199 there is a reference to red sandy loam, also to the ferruginous cap or crust. The latter is the parallel of the phenomena Prof. Lacroix describes on the "bowals" of French Guinea, and which he accepts as truly lateritic deposits. The cellular or vesicular structure is ordinarily found in lateritic layers formed in such a position. The lustrous surface is explained on a previous page; suffice it here to say that neither solar heat or leaching has any part in its formation, and that the iron in the lustrous coat is in a higher state of hydration as a rule than most of the iron in the body of such laterite.

On p. 200 the statement "In places fragments or masses of pebbly ironstone of heterogeneous composition can be seen adhering to bare unweathered surfaces of granite, sandstone, and other rocks" supports my own observation of laterite lying on bare unaltered granite, and is additional evidence as to the slight change effected by weathering on unaltered crystalline rocks in the tropics. The platforms described here are exactly parallel with the laterite river terraces previously mentioned, the origin of which has been explained as in no way connected with alternating periods of varying humidity.

On pp. 90·1 is a description of the structure of two hills at Kano. There are more of the same type in Nigeria on which laterite, often highly aluminous, overlies crystalline rock with an altered bleached layer intervening. The whole description apart from the presence of the altered layer might be that of certain occurrences in French Guinea.

The detrital surface layer—"sub-angular fragments of quartz and rolled pebbles of ironstone"—gives certain information, and the deductions are exactly the same as the writer made concerning laterites of this type in French Guinea. It is curious to find this assertion following: "No facts have been ascertained with regard to the occurrence of true lateritic material either in the original sheet of weathered rock or in the drifted alluvium." Its immediate qualification is very interesting: "There is some reason to believe however that the surface ironstones in places contain considerable quantities of free alumina." One really wonders what additional evidence was considered necessary in order to establish the fact that these deposits are truly lateritic. It is not really difficult to prove the presence of free alumina by chemical analysis; it is a pity it was not done and these so-called ironstones called by their proper name. The great majority need not even be subjected to chemical analysis, for the microscope reveals the presence of gibbsite in their sections in almost every case. It occurs quite freely in the quartzose laterites along the banks of the Kaduna river and is more abundant in the older beds, some indeed containing quite 75% of this mineral.

On p. 205 it is interesting to find Dr. Falconer quoting M. Chantard as having noted the similarity of the recent ferruginous deposit of Hausaland and those of Haute Guinée. Prof. Lacroix recognizes the latter as being truly laterite. The writer has proved them in both places both by analysis and the microscope to be lateritic, and it is impossible to doubt that the use of such names as surface ironstone is wrong.

On p. 206 Dr. Falconer admits that the conditions necessary for the production of bog iron ores in Northern Nigeria are non-existent. These ferruginous (and aluminous) deposits are invariably lateritic. Many do not resemble typical laterite or contain enough lateritic constituents to be called laterite in the sense in which Dr. Fermor uses the word, but nevertheless they are as truly lateritic as any deposit of equal age and similar mode of occurrence can be.

On p. 208 we find ". . . . . the subsequent rise and redeposition of the iron ores above ground water-level is accomplished during periods of less relative humidity." Mention is also made of "more rapid evaporation of the ferruginous solutions" as determining the deposition of ferric hydrate. It is when water-level is at its highest that most iron is deposited and the hard lustrous crust formed. Evaporation of ferruginous solutions does not bring about precipitation of iron, for it is present in the ferrous, never in the ferric state. Oxidation is necessary. Even a very dilute solution of ferrous iron such as occurs in nature yields the whole as ferric hydrate almost instantly upon coming into contact with the atmosphere.

On p. 210 we find: "Under present conditions however the amount of iron salts dissolved in the ground water must be relatively less than it would be at the close of a period of maximum humidity." This statement must be questioned. Compare the water of Murchison district, Western Australia, with that of the eastern part of New South Wales. The amount of iron present in vadose water does not necessarily determine the amount of ferric hydrate deposited at or near the surface, since it is deposited only on contact with oxygen. It is only when the conformation of the surface is such that vadose water passes at or near it that oxygen gets an opportunity to precipitate iron. Vastly the greater part of iron dissolved by vadose water is not precipitated from it in the strata but drains away in solution into streams and is lost.

On p. 221 Dr. Falconer says that the removal of vegetation from the ironstone can be accomplished only by climatic change. This is proved not to be so. The cause is explained on a previous page. The writer, contrary to Dr. Falconer's assertion, never attributed deforestation to the influence of man. The only influence on any factor in laterization assigned to man was the production of alkaline carbonates by the annual burning of grass in Africa.[52] These are clearly stated to result from the decomposition of vegetable matter, but that little decomposes in Haute Guinée, nearly all being burnt, but that in this way also alkaline carbonates are produced. This has no connection with deforestation since, as is well known, grass fires do not destroy the trees. Large areas of Nigeria are burnt annually in the same way without materially affecting forest growth.

[52] Tran. Inst. Min. Met. Vol. xix. p. 439.

Fuel Research.

The Fuel Research Board appointed by the Committee of the Privy Council for Scientific and Industrial Research has issued a report giving an outline of the problems and the methods proposed for tackling them. In the first place, chemical and physical examinations are to be made of the coal obtained at the various mines, and second, investigations will be conducted with the object of ascertaining the gaseous, liquid, and solid products obtained by coking at temperatures lower than those used at gas works and coke ovens. We reviewed the fuel problem in our issue of March last and pointed out that the difficulties in the way of economically obtaining gas, benzol, oil-fuel, etc., from coal is that at least 75% of the coal is transformed into coke, a material for which there is not an unlimited demand. An important part of the research work of the Fuel Board is to be devoted to the question of producing a more freely burning coke obtained by carbonization at lower temperatures.

A few of the problems before the Board are as follow: (1) Can the 35 to 40 million tons of raw coal used every year for domestic heating be wholly or partly replaced by smokeless fuel, solid and gaseous, prepared by the carbonization of this coal? (2) Can adequate supplies of fuel oil for the Navy be obtained by carbonization of the coal which is at present used in its raw form for industrial and domestic purposes? (3) Can supplies of town gas be obtained more economically and conveniently by methods of carbonization and gasification other than those at present in use in gas works? (4) Can electric power be obtained more cheaply if the coal used for steam raising is first subjected to processes of carbonization and gasification? (5) Can the use of gaseous fuel in industrial operations be forwarded by the development of more scientific methods of combustion in furnaces, muffles, and ovens used in metallurgical, ceramic, and chemical operations? (6) Will the more scientific development of the preparation and use of fuel enable the peat deposits of the United Kingdom, particularly Ireland, to take a serious place as economic sources of fuel for industrial purposes?

With regard to the disposal of coke, if low temperature carbonization is to be established on a sound economic basis, the research scheme is to include a complete inquiry on three main lines: (1) The use and value of this coke for the direct firing of steam boilers; (2) Its gasification in producers for the manufacture of low-grade fuel gas and the recovery of its nitrogen as ammonia; (3) Its use for industrial and domestic heating either directly, as it comes from the retorts, or after its conversion into briquettes. The second of these inquiries will involve the development of a special form of gas producer and auxiliary plant if the best results are to be obtained from the coke. It will also involve the development of a system of boiler firing in which fuel gas of 130 B.T.U. can be burned at least as efficiently as coal both as regards thermal efficiency and the effective evaporation per square foot of heating surface.

LETTERS TO THE EDITOR

Tin and Wolfram Lodes.

The Editor :

Sir — Dr. Malcolm Maclaren's article on "The Geology of the East Pool Mine" in your May number is of considerable interest and value, not only as a contribution to economic geology, but also as showing the importance of geological knowledge coupled with careful observation in dealing with deposits such as those of tin ore and wolfram, which differ both as to their origin and mode of occurrence from almost all other ore deposits. It is to be hoped that the article will encourage mining companies to make greater use of mining geologists to examine their properties, for in no department of knowledge have we, as a nation, failed to keep abreast of other nations, notably of America, more than in the study of ore deposits.

The writer welcomes the appearance of the article also because it supports, in a marked manner, the conclusions to which he came on the origin of the tin ore deposits of Malaya. Dr. Maclaren agrees with the writer as to the existence of previously formed fissures, and regards the lode stuff as fillings of these fissures by the residual granite magma, and the tin ore, wolfram, etc., in the lodes as having been deposited from metalliferous gases and solutions which passed through the partly filled fissures, and altered the walls and filled the open spaces. The writer expressed his views on the origin of tin ore in Malaya in almost identical language in his article on "Mineralization in Malaya" in your issues of October and December of 1915.

There are many other points of interest arising from the article, among which are the following :

(1) The occurrence at East Pool of two sets of fissures, of different ages, but both fully developed prior to the period of filling. There is conclusive evidence also in Malaya and Lower Burma that there were at least two sets of fissures in existence prior to the latest phase of the granite intrusion, and that these fissures were first filled with the residual acid magma left after the main granite intrusion, and that in this way were formed the numerous quartz and pegmatitic veins so common in both countries, and intrusive into granite and schist in the Tavoy District, and into granite, schist, and limestone in Malaya. As a final stage of this intrusion of quartz, pegmatite, and aplite veins and before the consolidation of the magmas, came the mineralizing gases and solutions from which were deposited tin ore and wolfram. The main fracture lines in the Tavoy District had a general N—S direction, and the subsidiary fractures a direction at right angles to this. The fractures in Malaya vary in their direction in different parts of the peninsula, but the main fractures in the famous Kinta Valley have a general direction NE—SW, and the subsidiary fractures run NW—SE, while in the Rawang—Serendah Districts the main fractures have a bearing of 20° N of W to 20° S of E.

(2) The presence of andalusite in the killas within 500 ft. of the granite contact. Andalusite is very common in the schist of the Tavoy District in Burma and also in Malaya, but it is known to occur at a considerably greater distance than 500 ft. from the granite contact, so that the presence of andalusite cannot in these countries be considered an indication that the granite contact is so near. This is probably due to the greater metamorphic action of the enormous granite bosses in these countries.

(3) The presence of secondary scheelite in cleavage cracks in wolfram. This is very interesting and may account for the presence of the little scheelite there is in one or two mines in Tavoy District. It is possible, however, that the little scheelite found in the Pagaye mine, Tavoy, for example, is primary, the calcium being derived from the mica schist, and there is some evidence that this is so. In Malaya there is a considerable amount of scheelite, but this occurs in veins in the limestone and is not secondary after wolfram.

(4) At East Pool the wolfram zone occurs near the top of the tin zone. Dr. Maclaren states that it is impossible to ascribe the vertical succession of mineral to any other cause than the decreasing temperature of metalliferous solutions with approach to the surface. Evidence is rapidly accumulating that, in general, wolfram was deposited at lower temperatures than was tin ore, and the writer, in the discussion on the paper by Mr. Maxwell Lefroy on "Wolframite Mining in the Tavoy District, Lower Burma" (read before the Institute of Mining and Metallurgy on December 16, 1915), pointed out that the probable reason why Lower Burma carried more wolfram in proportion to the tin ore than did Malaya was that the lower part of the peninsula had suffered greater denudation than had Lower Burma, and adduced, in support of this theory, the fact that in Mergui District, which is between Tavoy and the Malayan tinfields, the proportion of tin ore to wolfram was greater than at Tavoy District, and less than in Malaya. This theory has to be taken in a broad and general way, for even in the Tavoy District there is one mine which carries tin ore with no wolfram, others in which the ores are present in almost equal proportions ; and in the Mergui District one or two mines carry wolfram with very little tin ore, whereas the Titi tin mine in Negri Sembilan, Malaya, differs from almost all the other Malayan tin mines in carrying a very high percentage of wolfram in the tin ore. These mines, however, have interesting peculiarities which, instead of militating against the theory of unequal denudation, strongly support this theory that the relative proportions of tin ore and wolfram are clearly related to the temperature zones in which the ores were deposited.

Although temperature is undoubtedly a most important factor in governing the loci of deposition of tin ore and wolfram it would be unsafe to draw the general conclusion that wolfram will, in all cases, give place below certain depths to tin ore. Dr. Maclaren does not, it is noticed, draw such a general conclusion. In a compact and extensive boss of granite, for example, a certain high temperature zone would be nearer the periphery of the boss than would the same temperature zone in a granite much fractured when in the act of consolidating, and a temperature sufficiently low for the deposition of wolfram would be found considerably lower in veins of pegmatite and quartz than would be the case in a more compact granite intrusion. It is possible that in a region where two pegmatite or quartz veins cut one another the temperature in that area was lower than it was in the igneous mass at points considerably nearer the surface, for it is now well established that mineralized pegmatite and quartz veins were deposited at comparatively low temperatures. We have the case of the lode at Sadisdorf (see J. T. Singewald Junr., "The Erzgebirge Tin Deposits" *Economic Geology*, Vol. V. pp. 176/7, 1910) in which tin ore actually gives place at depth to wolfram as an interesting exception to prove the rule, but so far as the writer knows no explanation has been given for this phenomenon. Possibly the temperature *below* the tin ore zone was, at the time of deposition, actually *lower* than it was above that zone from causes which are not inconceivable.

It would not be a simple piece of work to map the relative temperature zones which obtained in a mineralized area carrying tin ore and wolfram at the period of mineralization, but in an old well-developed mining field, like Cornwall, with its zones of sulphides, of wolfram, and of tin ore, it would not be impossible to do so on very general lines. Such a map would possibly show high and low temperature areas without apparent explanation, and thus lead to further fruitful research.

It is often stated by mining men in the Tavoy District that no lodes have hitherto been proved here to carry wolfram below 300 to 400 ft. It could with more truth be stated that no lode has hitherto been tested at a depth below which it has been found not to carry wolfram. The deepest cross-cut in the district, which is only about 400 ft. below the surface, has proved the presence of wolfram; but it does not require artificial cross-cuts to establish this, for nature has provided us with many in the form of deep valleys, and has definitely proved, in the exposed lodes, that wolfram does occur in workable amounts at depths of several hundreds of feet below the great majority of the present workings. Dr. Maclaren tells us that at East Pool, in the Great Lode, wolfram was most plentiful from the 140 to the 196 fathom levels, and this should encourage deeper mining in the Tavoy District, where at present almost all the workings are confined to depths of a few fathoms below the surface even where the lodes are in mica-schists capping the granite.

William R. Jones.

Tavoy, Lower Burma, August 20.

NEWS LETTERS.

CAMBORNE.

Parliamentary Representation. — The Cornish Chamber of Mines has scored a distinct success in its first effort to effectively represent the mining industry as a whole. In the bill for the rearrangement of the parliamentary divisions of the country, it was proposed to absorb the old-time Cornwall Mining Division into one to be named the Penryn-Falmouth division. All interested in Cornish mining will appreciate the loss which the absorption of so traditional a name as the Mining Division would have meant to the industry. Happily, the Chamber of Mines hit on the alternate plan of dividing West Cornwall into two divisions according to their industries, and this constructive proposal appealed to the Boundary Commissioner, and has been adopted. One of the divisions will consist of the towns of Camborne and Redruth and the many outlying villages, where the main industry is mining, and the other of the towns of Falmouth, Penzance, and St. Ives, and their contiguous areas, which mainly subsist on the shipping industry. It will be an inestimable advantage to the mining industry to have a member in the next Parliament who will more directly represent it, especially in view of probable Government action in the development of the county's mineral resources. When the time comes, it is reasonable to hope that a candidate will be put forward who has been associated with the industry, and is thoroughly familiar with its needs and possibilities. Many people had begun to wonder whether the Cornish Chamber of Mines had died of inanition; the action of the Council in this matter shows, on the contrary, that the Chamber is a live organization. It is to be hoped that the Council will be encouraged by this success to tackle at once the many other matters that are crying out for attention.

Industrial Councils. — The recent decision of the Government to encourage the establishment of industrial councils with a view to securing closer co-operation between employers and employed in the many pressing matters that render essential the arrangement of a capital and labour concordat, is one of far-reaching importance, and one, too, that needs the immediate consideration of the leaders of the mining industry. The need for capital and labour to work hand in hand to promote the productivity and prosperity of the Cornish mining industry is obvious; the establishment of such a council should lead to the elimination of the great majority of disputes, encourage a larger and more far-seeing view in matters of mutual concern, and do much to foster a sense of identity of interest between employer and employed. The Government has decided that these joint industrial councils are to be recognized as "the official standing consultative committees to the Government on all future questions affecting the industries they represent, and they will be the normal channel through which the opinion and experience of an industry will be sought on all questions with which the industry is concerned." In effect, then, whenever the Government wishes to know anything about an industry, it will automatically choose the industrial council as that industry's recognized mouthpiece.

The Cornish mining industry is looking to the Government for a good deal of support in one direction or another; the establishment of an industrial council is a means to that end that surely should not be neglected. The employers may be said to be organized through the Chamber of Mines, and the employees through the Workers' Union, so that no difficulty in that direction presents itself. It will be recalled that, only in the last issue, I directed attention to the hold which the Workers' Union had at last got on the miners, and suggested that the time was speedily coming when that organization would have to be recognized by the employers. A good opportunity for such recognition now appears to have arrived, and, in the best interests of the industry, advantage should be taken of it.

Royalties.—Since the last issue, the principle of royalties has been discussed by Parliament in connection with the Petroleum Bill, and it is of interest to note that it was decided to strike out the provision made for the payment of a royalty of 9d. for every ton of petroleum raised in the United Kingdom. It was very properly pointed out that we were asked to tax all our future production in order to pay gratuities to landlords, who had not lifted a finger to develop the properties, and so burden capital, labour, and consumers alike for an indefinite period. A parallel case to some extent is to be found in the Cornish mining industry—Dolcoath is a particular instance at the present time—and inconsiderate landlords will be well advised to read aright the handwriting on the wall.

Price of Coal.—The intimation that the Coal Controller has authorized an advance of 2s. 6d. per ton of coal is likely to prove a serious matter for some Cornish mines. It is particularly unfortunate that the mines with the heaviest pumping charges—such as Basset and Grenville—and by whom this extra burden will be most felt, should be operating already at a loss. The consumption of coal at Basset will certainly average 16,000 tons, so that the advance in the price of coal will cost this mine at least £2,000 per annum.

Cornish Wolfram Mines.—It is officially reported that the south lode at the 44 fm. level in the Park-an-chy mine has been driven west for some months past, and that the lode will average 4% tin and wolfram over a width of 4 ft. Recently, however, the lode has widened to about 10 ft, and the vanning assay shows the lode to average 15 to 17½%—mostly tin—over 7 ft.; the remaining 3 ft. averaging about 2%. This is satisfactory news. The mill is practically complete and will be started shortly, dealing in the first instance, at any rate, with the wolfram ore developed on the main lode, the reserves on which are estimated at 25,000 tons.

WAGES.—The Workers' Union, on behalf of its members, has made application to the principal mines for increases in minimum wages as under:

	£ Per Month
Contract and tribute men	8
Machine rock-drillers	12
Timber and shaft men	8
Trammers	7
Mechanics	7
All surface men	6

The number of eight-hour shifts to be worked per month is to be twenty-two. Probably, at most of the mines, contract men do already earn £8 per month, unless they are irregular in attendance and poor miners, but to guarantee £8 per month, irrespective of the amount of work done, is a proposition of a very different colour. This is a reversion to day pay, with all its attendant evils. With a contract, men have the opportunity, if they will work reasonably well, of making good wages—the sum they earn depends largely on themselves—but if they are to be guaranteed a minimum wage of £8 per month, one may be quite sure that there will be a substantial fall in the output in a large percentage of cases, or, in other words, in the cases of those who have little regard for the interests of the employer. How a minimum wage can be applied to a tributer is a mystery to the writer, of course, assuming that a tribute bargain continues to be a system of working in which the worker participates in the varying value of the ore. A tributer backs his knowledge of the ground when the tribute is set, but if he is to have a minimum wage of £8 per month, he will take no risk, and yet share anything good he may find. It is obvious that the officials of the Union know little about tutwork and tribute. If, too, the minimum wage is to be based on 22 shifts per month of eight hours, presumably any further hours worked will be overtime. The whole proposals are so impracticable as to emphasize the need for a conference with the Union officials, who, although obviously knowing little of the conditions, presumably have no wish to cripple the industry. The employers are, speaking generally, anxious that the men should earn good wages, and if they care to work regularly and are competent, there need be no difficulty in securing wages well in advance of the minimum schedule given above.

LEVANT.—For the 16 weeks ended October 20 last, a profit has been earned of £1,287, as compared with £676 for the previous four months. This increased profit is obviously due to sales of arsenic, and to the larger output of copper ore, for the sales of tin show a fall from 123 to 109 tons. The development ends would appear to show little variation in values, but one is not able to speak very definitely, for although money values per fathom continue to be given, neither assays per ton nor the width of the lode is stated. The prices at which the ends are being driven are also given, but of what value is this information? Surely the time has come when even a mine run on cost-book principles should issue reports that are intelligible. It is gratifying to see this grand old mine once again being worked at a profit, and it is to be hoped that the wise policy will be continued of accumulating a substantial reserve against future contingencies.

RESEARCH FUND.—A conference, called by the Ministry of Munitions, has been recently held to consider ways and means of raising money to continue the researches undertaken in connection with the recovery of tin and wolfram from Cornish ores. It is suggested that the mineral lords and the mining companies should contribute to a fund for this purpose, to which doubtless the Privy Council would also contribute. There is general agreement that it is highly desirable that the research work carried out by the Committee appointed by the Institution of Mining and Metallurgy and the Royal Cornwall Polytechnic Society should be continued, although under the new scheme the control would be vested in the Privy Council Committee, coupled with representatives of the industry, and of the Department for the Development of Mineral Resources.

PERSONAL.

THOMAS EASTON ALLAN has joined the board of Robey & Co. Ltd., Lincoln.

CHARLES P. C. BERESFORD, manager of the Prestea Block A, is in London.

W. F. COLLINS has returned from China and is engaged in the organization of Chinese labour in France.

CLEMENT DIXON has been appointed a Justice of the Peace for Southern Rhodesia, and has been re-elected, unopposed, for a further term of three years, as a Town Councillor for Bulawayo.

J. F. DOBSON has been appointed London manager for Bruce Peebles & Co., Limited, of Edinburgh.

LIEUTENANT-COLONEL ALFRED WINTER EVANS, of the New Zealand Rifle Brigade, has been killed in action in France.

TEMPORARY MAJOR M. A. FRANCIS, of the Welsh Regiment, was married on October 15 to Miss Gladys Lee Greatbanks, of Hoole, Chester.

HARRY D. GRIFFITHS left London for Burma on November 10.

LIEUTENANT A. TREVELYAN KING was recently spending a few days leave in Cornwall.

PROFESSOR HENRY LOUIS was recently elected president of the Society of Chemical Industry.

W. A. LUNING has joined the board of the South Bukeru Tin Company.

JOHN MCDERMOTT, formerly manager of the Sons of Gwalia, is now in charge of the Ivanhoe mine at Kalgoorlie.

F. H. MASON has joined the staff of the *Mining and Scientific Press* as assistant editor.

SIR NEWTON MOORE, formerly Premier of West Australia, and recently Agent-General for that State in this country, has joined the board of the Great Boulder Proprietary.

WILLIAM PICKERING, D.S.O., secretary of the De Beers Consolidated, has been appointed to a directorship, and E. F. RAYNHAM, D.S.O., succeeds him as secretary.

GEORGE READMAN has been elected chairman of the Arizona Copper Co., Ltd., in succession to Lord Salvesen who has retired.

SIR BOVERTON REDWOOD has been appointed Director of Technical Investigations in the Petroleum Executive.

DR. A. L. SIMON has returned from Russia.

N. L. WARFORD has gone to the copper mines of Catemou, Chile, to superintend the application of powdered coal to copper smelting.

HORACE V. WINCHELL has returned to America after examining the Ashio copper mine, Japan.

METAL MARKETS

COPPER.—The prices fixed by the Government continue to rule at £110–£110. 10s. both for cash and 3-months standard, and at £125–£121 for electrolytic. Supplies are still in urgent demand and the loss of one or two important shipments has put somewhat of a strain on stocks. In America the quotation remains at 23½ cents f.o.b. New York, although second hands are reported to have obtained as much as 28½ cents from needy consumers. The business put through at this price, however, must have been insignificant, as stocks in dealers' hands are of necessity small to allow of such a premium. Recently published figures show a considerable falling off in the American production of the metal, the effect of the recent strike. The labour situation, however, is again improving, and it is believed that the September output will prove to be the low-water level. Control is gradually getting into its swing, and sales at high premiums should no longer be possible. There is some talk of a revision of the sale basis on a higher level. But if the labour question is got out of the way, with a consequent increase of production, the question of increasing the price will soon disappear, especially as the withdrawal of labour for military service tends to decrease the demand in unessential trades.

Average prices of cash standard copper: October 1917, £110. 5s. 0d.; September 1917, £117. 15s. 0d.; October 1916, £122. 10s. 0d.

TIN.—Prices kept steady throughout October around £245, until right at the end when the quotation spurted to £259. Supplies have arrived more abundantly of late, with a consequent disappearance of the premium on cash of 70s., while the extra for Straits over standard has likewise decreased. American demand gradually strengthened as the month waned and as the market rose, buying power showing considerable activity at the higher levels, which the demand from other Allies came in to increase. The higher price combined with the fall in silver has induced China to sell to America, but little business is reported from Batavia. Home trade is more hopeful. A confident tone has manifested itself among tinplate makers owing to an increase in the amount of steel allocated to them for their trade. In English tin a good trade continues to be put through, and prices are firm.

Average prices of cash standard tin; October 1917, £247. 9s. 4d.; September 1917, £243. 19s. 5d.; October 1916, £179. 8s. 2d.

LEAD.—The official price continues at £30. 10s. to £29. 10s. Supplies are still very short. In America the quotation has fallen to 6¼ cents, and a fair demand has arisen. There is not, however, much available for early delivery.

Average prices of soft foreign lead: October 1917, £30; September 1917, £30; October 1916, £30.

SPELTER.—There is no change in the official price of £54–£50. The market is healthy, and the supplies in dealers' hands are light. Business in Japan is curtailed owing to the difficulty of securing freight. £57 is being realized for English, for lots in warehouse. Complaints are heard that American spelter cannot be produced under 8c. in spite of abundant offers under that price.

The quotation for zinc dust on November 5 varied from £85 to £106. 10s. per ton according to quality.

Average prices of good ordinary brands: October 1917, £52; September 1917, £52; October 1916, £52. 4s. 4d.

SILVER.—The course of the market has been downward during the past month, and the dangerously high price, 55d., of six or seven weeks ago has given way to more normal levels.

NICKEL.—£225 per ton. BISMUTH.—11s. per lb.

CADMIUM.—8s. per lb.

COBALT.—The price a month ago was 12s. per lb., but owing to the demand, quotations are withdrawn.

PLATINUM.—New 290s. per oz.; scrap 260s.

CHROMIUM.—No quotations for chrome ores. Chromium metal 7s. 6d. per lb.; ferro-chrome £80 to £185 per ton according to carbon content.

TUNGSTEN.—Wolfram, 55s. per unit, 70% WO_3.

MOLYBDENUM.—Molybdenite, 90%, 105s. per unit.

No quotations for aluminium, antimony, manganese.

PRICES OF CHEMICALS. Nov. 9.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d.
Alum	per ton	17	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	32	0	0
,, Chloride of, grey	per cwt.	1	18	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	65	0	0
,, Phosphate of	,,	100	0	0
,, Sulphate of	,,	15	10	0
Arsenic, White	,,	120	0	0
Barium Sulphate	,,	6	0	0
Bleaching Powder, 35% Cl.	,,	20	0	0
Borax	,,	37	0	0
Copper, Sulphate of	,,	65	0	0
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		11	4
Iron, Sulphate of	per ton	8	0	0
Lead, Acetate of, white	,,	120	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	46	0	0
Magnesite, Calcined	,,	14	0	0
Magnesium Sulphate	,,	11	0	0
Phosphoric Acid	per lb.			10
Potassium Carbonate	per ton	155	0	0
,, Chlorate	per lb.		2	6
,, Chloride 80%	per ton	65	0	0
,, Hydrate, (Caustic) 90%	,,	400	0	0
,, Nitrate	,,	75	0	0
,, Permanganate	per lb		15	0
,, Prussiate, Yellow	,,		3	6
,, Sulphate, 90%	per ton	65	0	0
Sodium Metal	per lb.		1	9
,, Acetate	per ton	95	0	0
,, Bicarbonate	,,	7	15	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	4	5	0
,, Hydrate, 76%	,,	26	0	0
,, Hyposulphite	,,	25	0	0
,, Nitrate, 95%	,,	27	0	0
,, Phosphate	,,	32	0	0
,, Silicate	,,	7	0	0
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	35	0	0
Sulphur, Roll	,,	21	0	0
,, Flowers	,,	23	0	0
Sulphuric Acid, non-arsenical 144°T.	,,	4	5	0
,, non-arsenical 95%	,,	7	0	0
Superphosphate of Lime, 18%	,,	5	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
Year 1916	8,971,359	324,179	9,295,538	39,484,934
January 1917	756,997	25,637	782,634	3,324,418
February	696,955	24,366	721,321	3,063,976
March	760,598	26,496	787,094	3,343,363
April	717,598	25,180	742,778	3,155,121
May	753,531	26,034	779,385	3,310,618
June	732,799	26,925	759,724	3,227,101
July	731,848	25,991	757,839	3,219,094
August	731,405	25,253	756,658	3,214,079
September	712,881	25,350	738,231	3,135,807
October	724,846	26,444	751,290	3,191,279

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1916	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500
October 31	199,330	10,907	6,358	216,595
November 30	196,132	11,118	5,928	213,178
December 31	191,547	11,487	5,194	208,228
January 31, 1917	188,624	11,611	5,591	205,826
February 28	191,095	11,568	6,268	208,931
March 31	190,028	11,494	6,620	208,142
April 30	185,975	11,435	6,314	203,724
May 31	180,168	11,432	5,805	197,405
June 30	175,727	11,258	5,369	192,354
July 31	171,653	11,381	5,223	188,257
August 31	170,817	11,401	5,028	187,246
September 30	171,334	11,601	4,791	187,726
October 31	170,331	11,841	4,620	186,792

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
July 1916	2,370,244	26 1	17 10	8 0	949,606
August	2,423,669	26 3	17 10	8 1	976,125
September	2,367,793	26 6	18 0	8 3	972,704
October	2,453,437	26 4	17 10	8 2	1,001,843
November	2,389,056	26 9	18 2	8 2	980,387
December	2,349,191	26 10	18 2	8 4	977,481
January 1917	2,337,066	26 10	18 8	7 11	941,520
February	2,153,691	27 3	19 2	7 10	841,259
March	2,430,590	26 7	19 0	7 4	879,351
April	2,235,833	27 2	19 2	7 8	857,710
May	2,405,855	26 4	18 7	7 5	887,527
June	2,288,426	26 11	19 2	7 7	867,639
July	2,294,668	26 11	19 0	7 7	869,577
August	2,301,892	26 9	19 0	7 6	859,517

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1916	1917	1916	1917
	£	£	£	£
January	318,586	296,113	140,579	131,665
February	313,769	289,734	137,739	104,892
March	335,368	300,183	150,987	158,727
April	339,386	297,977	135,976	123,825
May	323,783	299,271	132,976	121,104
June	333,070	302,195	127,107	114,489
July	322,365	288,731	128,574	142,017
August	338,001	294,359	125,143	130,278
September	322,035	291,367	127,138	127,168
October	325,608	...	132,577	...
November	317,135	...	130,101	...
December	306,205	...	146,409	...
Total	3,895,311	2,658,930	1,615,356	1,154,165

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
July, 1916	912	91,725	92,637	393,495
August	*	89,522	*	*
September	*	85,978	*	*
October	*	82,732	*	*
November	*	87,322	*	*
December	*	88,205	*	*
January 1917	*	83,962	*	*
February	*	81,810	*	*
March	*	76,171	*	*
April	*	82,144	*	*
May	*	78,165	*	*
June	*	82,600	*	*
July	*	81,166	*	*
August	*	80,181	*	*
September	*	81,761	*	*
October	*	73,901	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1916	1917	1916	1917	1916	1917
	£	£	£	£	£	£
January	89,900	67,627	66,700	50,150	39,000	29,000
February	76,500	65,450	79,050	63,200	30,000	26,000
March	103,600	74,794	76,920	61,200	36,000	41,000
April	60,000	75,139	83,300	62,470	63,000	21,000
May	119,500	65,623	116,230	65,450	19,000	28,400
June	86,000	64,180	72,200	73,100	18,000	24,600
July	100,600	...	85,400	71,820	23,000	44,000
August	66,800	...	86,000	74,800	24,000	21,000
September	115,100	...	65,450	64,180	32,000	20,000
October	81,400	...	74,800	...	32,000	...
November	94,000	...	60,300	...	31,000	...
December	96,600	...	73,550	...	111,000	..
Total	1,090,000	348,633	939,900	616,370	458,000	255,000

Production of Gold in India.

	1914	1915	1916	1917
	£	£	£	£
January	193,140	201,255	192,150	190,047
February	185,508	195,970	183,264	180,904
March	191,853	194,350	186,475	189,618
April	189,197	196,747	192,208	185,835
May	193,031	199,786	193,604	184,874
June	192,224	197,447	192,469	182,426
July	195,137	197,056	191,404	179,660
August	196,560	197,984	192,784	181,005
September	195,843	195,952	192,330	183,630
October	198,191	195,531	191,502	182,924
November	197,699	192,714	192,298	...
December	211,911	204,590	205,164	...
Total	2,340,294	2,369,382	2,305,652	1,840,923

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper Standard	Copper Electrolytic	Copper Best Select'd	Soft For'n Lead	Zinc	Tin Standard	Silver
Oct.	£	£	£	£ s.	£ s.	£ s. d.	d.
11	110	125	123	30 10	54 0	246 0 0	44¾
12	110	125	123	30 10	54 0	246 10 0	44¼
15	110	125	123	30 10	54 0	246 10 0	43¾
16	110	125	123	30 10	54 0	247 0 0	43⅜
17	110	125	123	30 10	54 0	247 10 0	43⅛
18	110	125	123	30 10	54 0	249 0 0	42⅞
19	110	125	123	30 10	54 0	249 0 0	42⅝
22	110	125	123	30 10	54 0	248 0 0	42⅛
23	110	125	123	30 10	54 0	247 10 0	41⅞
24	110	125	123	30 10	54 0	247 10 0	41⅞
25	110	125	123	30 10	54 0	247 5 0	41⅞
26	110	125	123	30 10	54 0	247 10 0	42¼
29	110	125	123	30 10	54 0	250 10 0	43
30	110	125	123	30 10	54 0	256 5 0	46
31	110	125	123	30 10	54 0	257 5 0	45¾
Nov.							
1	110	125	123	30 10	54 0	258 0 0	45⅜
2	110	125	123	30 10	54 0	258 0 0	45⅛
5	110	125	123	30 10	54 0	260 0 0	44½
6	110	125	123	30 10	54 0	263 0 0	44¼
7	110	125	123	30 10	54 0	266 0 0	44
8	110	125	123	30 10	54 0	265 10 0	43¾
9	110	125	123	30 10	54 0	267 0 0	43¾

Imports of Ores and Metals into United Kingdom.

These figures now include Government imports.

* Statistics not published. Long tons.

	Year 1916	Sept. 1917	Year 1917
	Tons	Tons	Tons
Iron Ore	6,905,936	*	*
Copper Ore	34,492	*	*
,, Matte and Precipitate	43,839	4,266	18,924
,, Metal	111,412	22,006	97,803
Copper and Iron Pyrite	951,206	*	*
Tin Concentrate	33,912	*	*
,, Metal	33,646	1,525	20,518
Manganese Ore	439,509	*	*
Lead, Pig and Sheet	157,985	19,692	105,800
Zinc (spelter)	53,324	8,182	46,147
	lb.	lb.	lb.
Quicksilver	2,556,214	94,425	1,796,435

Exports of Copper from United States

These figures are circulated by news agencies and it is not always possible to verify their correctness.

1916	Long tons	1916	Long tons	1917	Long tons
January	21,863	July	35,048	January	25,540
February	20,548	August	34,700	February	21,937
March	24,006	September	28,572	March	51,246
April	19,980	October	32,712	April	79,001
May	14,700	November	21,433	May	45,241
June	38,277	December	21,438	June	39,816
		Total 1916	313,277	Total 1917	265,783

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1916 Tons	Sept. 1917 Tons	Year 1917 to date
Bisichi (Nigeria)	473	20	208
Briseis (Tasmania)	467	31	274
Dolcoath (Cornwall)	1,076	65	648
East Pool (Cornwall)*	1,012	82	774
Gopeng (F.M S.)	1,113	87	799
Malayan Tin (F.M.S.)	1,104	81	601
Mongu (Nigeria)	576	45	421
Naraguta (Nigeria)	523	45	368
N. N. Bauchi (Nigeria)	578	50	405
Pahang (F.M.S.)	2,591	205	1,930
Rayfield (Nigeria)	658	60	470
Renong (Siam)	894	92	768
Siamese Tin (Siam)	906	60	617
South Crofty (Cornwall)*	700	57	516
Tekka-Taiping (F.M.S.)	651	36	313
Tongkah Harbour (Siam)	1,135	80	918
Tronoh (F.M.S.)	1,662	94	793

* Including Wolfram.

Stocks of Tin.

Reported by A. Strauss & Co. Long tons.

	Aug. 31, 1917	Sept. 30, 1917	Oct. 31, 1917
	Tons	Tons	Tons
Straits and Australian, Spot	2,277	2,031	2,660
Ditto, Landing and in Transit	1,527	263	2,240
Other Standard, Spot and Landing	964	947	915
Straits, Afloat	4,973	6,420	*3,825
Australian, Afloat	—	—	—
Banca, on Warrants	—	—	—
Ditto, Afloat	2,147	1,620	*1,670
Billiton, Spot	—	—	—
Ditto, Afloat	273	300	*200
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,045	1,050	*1,000
Afloat for United States	5,380	4,547	*4,325
Stock in America	2,092	2,397	1,657
Total Stock	20,678	19,575	18,402

* Estimated.

Shipments and Imports of Tin

Reported by A. Strauss & Co. Long tons.

	Year 1916	Oct. 1917	Total 1917
	Tons	Tons	Tons
Shipments from:			
Straits to U.K.	27,157	*2,300	23,799
Straits to America	25,943	*2,300	20,277
Straits to Continent	8,487	*500	8,290
Australia to U.K.	2,537	—	349
U.K., Holland, and Continent to America	14,863	635	10,920
Imports of Bolivian Tin into Europe	15,116	2,097	15,008
Deliveries in U.K.	16,862	1,523	11,696
" " Holland	943	*90	1,617

* Estimated.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1912	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531	667
February	240	427	469	358	528	646
March	247	510	502	418	547	655
April	141	430	482	444	486	555
May	144	360	480	357	536	499
June	121	321	460	373	510	462
July	140	357	432	455	506	465
August	201	406	228	438	498	536
September	196	422	289	442	535	500
October	256	480	272	511	584	...
November	340	446	283	467	679	...
December	310	478	326	533	654	...
Total	2,540	5,103	4,708	5,213	6,594	4,985

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons
January	4,121	4,983	4,395	4,316	3,558
February	3,823	3,555	3,780	3,372	2,755
March	3,562	3,839	3,653	3,696	3,286
April	4,066	4,087	3,619	3,177	3,251
May	4,319	4,135	3,823	3,729	3,413
June	3,993	4,303	4,048	3,435	3,489
July	4,245	4,582	3,544	3,517	...
August	4,620	3,591	4,046	3,732	...
September	4,379	3,623	3,932	3,636	...
October	4,409	3,908	3,797	3,681	...
November	3,976	4,085	4,059	3,635	...
December	4,614	4,351	4,071	3,945	...
	50,127	49,042	46,767	43,871	19,752

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
January 2, 1917	176	£17,677	£100 8 10
January 15	160¾	£16,681	£103 15 5
January 29	152	£16,095	£105 17 10
February 12	182¼	£20,649	£113 6 1
February 26	176¾	£19,700	£111 9 3
March 12	179	£20,468	£114 7 0
March 26	161¾	£19,875	£122 17 8
April 10	179	£22,024	£123 2 0
April 23	169	£21,429	£126 16 0
May 7	167	£22,248	£133 4 6
May 21	168¼	£23,772	£141 5 9
June 4	168	£22,474	£133 15 6
June 18	158½	£21,915	£138 5 4
July 2	159½	£21,661	£135 16 1
July 16	144¼	£18,896	£130 19 11
July 30	168	£23,225	£138 5 0
August 13	160¼	£21,757	£135 15 4
August 27	156½	£21,429	£136 18 6
September 10	160¼	£21,784	£135 18 9
September 24	153	£21,448	£140 3 9
October 8	160½	£22,160	£138 11 6
October 22	153	£21,712	£141 18 2
November 6	144¼	£21,063	£146 0 5

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Nov. 4, 1916 £ s. d.	Nov. 5, 1917 £ s. d.
RAND:		
Bantjes	14 0	3 0
Brakpan	4 15 0	5 12 6
Central Mining (£8)	7 0 0	6 5 0
Cinderella	6 0	4 6
City & Suburban (£4)	1 17 6	1 5 6
City Deep	4 7 0	3 5 0
Consolidated Gold Fields	1 15 0	1 13 6
Consolidated Langlaagte	1 8 9	1 2 0
Consolidated Main Reef	18 9	15 9
Consolidated Mines Selection (10s).	1 3 9	1 8 9
Crown Mines (10s.)	3 2 0	2 6 3
Daggafontein	15 0	1 8 0
D. Roodepoort Deep	12 6	12 6
East Rand Proprietary	15 6	7 3
Ferreira Deep	1 6 3	17 0
Geduld	2 7 3	2 0 6
Geldenhuis Deep	1 2 6	19 6
Gov't Gold Mining Areas	2 12 3	3 15 6
Heriot	2 9 6	1 16 3
Jupiter	8 0	5 0
Kleinfontein	1 9 6	1 3 9
Knight Central	12 6	3 0
Knight's Deep	1 5 6	12 6
Langlaagte Estate	16 3	16 0
Main Reef West	6 9	3 0
Meyer & Charlton	5 3 9	5 6 3
Modderfontein (£4)	18 17 6	23 12 6
Modderfontein B	6 16 3	8 11 3
Modder Deep	7 10 0	7 11 3
Nourse	1 10 0	1 2 0
Rand Mines (5s.)	3 18 9	3 1 3
Rand Selection Corporation	3 15 0	4 15 0
Randfontein Central	12 0	11 9
Robinson (£5)	16 3	18 9
Robinson Deep	1 13 9	1 7 6
Rose Deep	1 1 3	19 6
Simmer & Jack	6 9	6 0
Simmer Deep	4 9	3 0
Springs	3 5 0	3 18 9
Sub-Nigel	1 7 6	1 9 6
Van Ryn	2 0 0	1 13 0
Van Ryn Deep	3 8 9	3 15 6
Village Deep	1 10 6	1 3 9
Village Main Reef	17 0	14 0
Witwatersrand (Knight's)	2 13 9	1 17 6
Witwatersrand Deep	1 3 0	8 6
Wolhuter	10 9	7 9
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	13 9	1 0 0
Sheba (5s.)	1 9	1 3
Transvaal Gold Mining Estates	1 2 6	19 6
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	12 12 6	12 17 6
Jagersfontein	4 5 0	4 3 9
Premier Deferred (2s. 6d.)	5 15 0	7 10 0
RHODESIA:		
Cam & Motor	12 0	12 0
Chartered British South Africa	11 6	14 6
Eldorado	9 3	7 6
Falcon	15 9	18 0
Gaika	9 3	8 0
Giant	7 3	8 0
Globe & Phœnix (5s.)	1 11 3	1 12 6
Lonely Reef	19 6	1 11 6
Rezende	12 6	3 15 0
Shamva	1 3 9	1 16 3
Wanderer (3s.)	1 3	1 6
Willoughby's (10s.)	4 3	5 9
WEST AFRICA:		
Abbontiakoon (10s.)	6 0	4 3
Abosso	9 3	7 6
Ashanti (4s.)	17 3	1 1 3
Prestea Block A	8 0	5 6
Taquah	19 9	17 3
WEST AUSTRALIA:		
Associated Gold Mines	4 0	3 0
Associated Northern Blocks	3 0	2 9
Bullfinch	3 3	2 0
Golden Horse-Shoe (£5)	1 16 3	2 0 0
Great Boulder Proprietary (2s.)	11 6	13 3
Great Boulder Perseverance	6	6
Great Fingall (10s).	1 3	1 3
Ivanhoe (£5)	2 1 3	2 2 6
Kalgurli	8 0	10 0
Sons of Gwalia	14 0	13 6

GOLD, SILVER, *cont.*	Nov. 4, 1916 £ s. d.	Nov. 5, 1917 £ s. d.
OTHERS IN AUSTRALASIA:		
Mount Boppy, New South Wales	10 0	6 0
Talisman, New Zealand	10 0	10 0
Waihi, New Zealand	1 15 6	1 18 0
Waihi Grand Junction, New Z'lnd	16 6	18 0
AMERICA:		
Alaska Treadwell (£5), Alaska	2 16 3	—
Buena Tierra, Mexico	13 0	12 0
Camp Bird, Colorado	7 0	8 0
Casey Cobalt, Ontario	5 6	7 6
El Oro, Mexico	8 6	10 0
Esperanza, Mexico	10 0	8 6
Frontino & Bolivia, Colombia	12 9	13 0
Le Roi No. 2 (£5), British Columbia	10 0	7 0
Mexico Mines of El Oro, Mexico	3 17 6	5 17 6
Oroville Dredging, California	16 6	18 6
Plymouth Consolidated, California	1 0 0	1 3 0
St. John del Rey, Brazil	16 6	18 6
Santa Gertrudis, Mexico	10 9	14 6
Tomboy, Colorado	1 1 3	1 1 0
RUSSIA:		
Lena Goldfields	1 12 6	1 10 0
Orsk Priority	1 5 0	15 0
INDIA:		
Champion Reef (2s. 6d.)	7 0	5 6
Mysore (10s.)	3 15 0	3 2 6
Nundydroog (10s.)	1 7 6	1 7 0
Ooregum (10s.)	1 1 6	19 3

COPPER:

	Nov. 4, 1916 £ s. d.	Nov. 5, 1917 £ s. d.
Arizona Copper (5s.), Arizona	2 5 0	2 5 6
Cape Copper (£2), Cape Province	3 15 0	3 7 6
Chillagoe (10s.), Queensland	3	3
Cordoba (5s.), Spain	4 0	3 6
Great Cobar (£5), N.S.W.	2 3	1 6
Hampden Cloncurry, Queensland	1 17 9	1 11 0
Kyshtim, Russia	2 7 6	1 17 0
Messina (5s.), Transvaal	11 0	8 6
Mount Elliott (£5), Queensland	4 1 3	4 0 0
Mount Lyell, Tasmania	1 7 9	1 5 6
Mount Morgan, Queensland	1 12 6	1 14 0
Rio Tinto (£5), Spain	61 10 0	65 0 0
Sissert, Russia	1 0 0	1 5 0
Spassky, Russia	1 18 9	1 10 0
Tanalyk, Russia	2 11 3	1 10 0
Tanganyika, Congo and Rhodesia	2 10 0	3 12 0
Tharsis (£2), Spain	5 0 0	5 10 0

LEAD-ZINC:

	Nov. 4, 1916 £ s. d.	Nov. 5, 1917 £ s. d.
BROKEN HILL:		
Amalgamated Zinc	1 12 0	1 11 9
British Broken Hill	1 3 6	1 18 6
Broken Hill Proprietary (8s.)	2 14 6	2 11 6
Broken Hill Block 10 (£10)	19 0	1 4 6
Broken Hill North	2 7 0	2 15 6
Broken Hill South	8 3 9	9 5 0
Sulphide Corporation (15s.)	1 5 3	1 8 0
Zinc Corporation (10s.)	16 0	19 3
ASIA:		
Burma Corporation	4 0 0	4 1 3
Irtysh Corporation	2 4 6	1 10 0
Russian Mining	18 0	13 9
Russo-Asiatic	5 10 0	3 10 0

TIN:

	Nov. 4, 1916 £ s. d.	Nov. 5, 1917 £ s. d.
Aramayo Francke, Bolivia	1 6 3	1 13 9
Bisichi, Nigeria	10 0	14 3
Briseis, Tasmania	4 9	5 0
Dolcoath, Cornwall	9 9	11 0
*East Pool, Cornwall	1 15 0	14 6
Ex-Lands Nigeria (2s.), Nigeria	1 9	1 9
Geevor (10s.) Cornwall	10 3	18 0
Gopeng, Malay	1 10 0	1 11 3
Ipoh Dredging, Malay	15 6	17 0
Malayan Tin Dredging, Malay	1 18 9	2 0 0
Mongu (10s.), Nigeria	8 6	15 0
Naraguta, Nigeria	15 0	17 0
N. N. Bauchi Pref. (10s.), Nigeria	7 0	10 9
Pahang Consolidated (5s.), Malay.	11 9	12 0
Rayfield, Nigeria	8 0	11 9
Renong Dredging, Siam	2 1 3	2 6 3
Ropp (4s.), Nigeria	17 9	18 0
Siamese Tin, Siam	2 12 6	2 17 6
South Crofty (5s.), Cornwall	14 6	1 1 3
Tekka, Malay	3 5 0	3 12 6
Tekka-Taiping, Malay	2 10 0	3 10 0
Tronoh, Malay	1 10 0	1 11 3

* £1 shares split into 4 of 5s. each in August 1917.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

PREVENTION OF CAVING ON THE RAND.

A joint meeting of the Chemical, Metallurgical, and Mining Society of South Africa and the South African Institution of Engineers was held in June 30, when a number of papers were read and discussed dealing with methods of supporting the hanging wall on the Rand.

The first paper was presented by Percy Cazalet. In the course of his remarks, the author said that sand-filling alone would not give the necessary support during current mining operations, for two reasons: first, it is most difficult to apply to current stopes contemporaneously with the advance of the faces and sufficiently close to them to prevent the caving-in and sagging of the hanging wall in the space between the sand-filling and the face; second, the great depth of the workings of the future would cause increased difficulties in the lowering of the sand and in dealing with the water used for its transport. Dry lowering of sand into the mine is now being successfully applied, however, and therefore part of the above water difficulty is obviated.

Sand-filling can be and is satisfactorily used as support to the hanging-wall where the ore has been mined over large areas. The hanging wall is thus allowed to settle *en masse*, and the filling controls and minimizes the extent of settlement. This applies to its full extent only to those mines not subjected at the time of sand-filling to excessive weight, as the sand-filling can then be done before the collapse of the hanging wall. In mines already subjected to great pressure there would be no large areas standing open, unless this type of filling was used as an adjunct to some system of thorough packing. Thus sand-filling can best be used as a preventive rather than as a cure. As one example of the preventive use of sand-filling at the early stages in the life of a mine the shaft pillars could, with useful effect, be surrounded by sand in anticipation of the time when increased weight might reasonably be expected.

As alternatives for sand-filling there are the following methods of supporting the hanging wall in such close proximity to the working faces as is required in the heaviest mines, to prevent accidents to the workers and the hanging wall from caving:

(1) The packing or stowage of waste rock, which is either broken during development or stoping operations or specially broken for the purpose. This system has its special uses, and should undoubtedly be more generally used on the Rand than it is at present. The failure to so use waste rock more generally is due chiefly to the underground lay-out most usual on these mines, and also to difficulties created by the angle of dip, when such dips lie, say, between 15° and 40°.

(2) The square set method of timbering so well known in many mining districts of the world is entirely unused in the stopes on the Rand, due chiefly to the absence of local suitable timber and the high cost of imported timber and of skilled labour.

(3) The use of round timber for props, stulls, and pigstyes are other methods which are now largely used, especially in the last form. There are many mines now using pigstyes of both round and square timber with great success—in preference to leaving pillars—thereby solving some of the difficulties of the support of the hanging-wall at reasonable cost, for the moment. Quite recently a new form of built-up pigstye, consisting of blocks of end-grain timber spiked to binding planks, has been developed and largely experimented with on the Central Rand. Indications to date are such as to make one believe that this form of pigstye will supersede other and more generally known forms very largely. It must be recognized, however, that no form of pigstye, which is not filled either with waste or reef, is of the least use for the support of heavy ground except for the most temporary purposes. With the undoubted increase to be expected in the cost of suitable timber in the future, together with the increasingly large proportion of the stoped-out areas which will have to be covered by any form of pigstyes in order to keep the workings safe, the cost of this method must become prohibitive, especially when the stoping widths are great.

(4) The packing of ore actually broken at stope faces. In the writer's experience this is the only method which entirely meets the requirements—in workings where the angle of dip does not exceed 60°—of such conditions of weight as exist underground in some of the mines to-day and which will more commonly exist in more of the mines in the future.

The second paper read at the meeting was prepared by G. Hildick Smith and Paul Selby. This described the method of packing at the Ferreira Deep, and classified under (4) in Mr. Cazalet's paper. At the Ferreira Deep the reefs mined to-day are the Main Reef Leader and South Reef. On the western section of the mine the Main Reef Leader directly overlies the Main Reef, and in the upper levels of the mine the top bands of the Main Reef were usually included in the one stoping face, the average stoping width in these cases being about 92 inches. In the eastern section of the mine the Main Reef Leader only is stoped, the Main Reef being separated from it by a very thick parting, and the average stope width of the Leader stopes in this area being 70 in. The average Leader stoping width over the whole mine is now 73 in. The South Reef overlies the Main Reef with 80 ft. of intervening quartzite, the average stoping width on the South Reef being 61 in. Generally speaking, the hanging wall of the South Reef is stronger and more elastic than that of the Main Reef Leader; this is often due to the effect of South Reef pillars and blocked-out ground having a punching effect through to the Main Reef Leader. The dip of the reefs varies in the outcrop section from 80° to 29°; in the deep section the average dip is 29°. Other things being equal, the system of packing adopted depends on the degree of the dip. Prior to the amalgamation of the Ferreira and Ferreira Deep in 1912 trouble was first experienced on the deep section in the shafts. Unfortunately the shaft pillars left with the original system of supporting the hanging wall by pillars were of such a size and position as to defeat the object for which they were cut. In order to relieve the pressure on the shaft pillars a sand-filling scheme was adopted, and actual filling commenced in June, 1910. As the breaking up of the hanging wall all over the deep section of the mine continued and stopes were constantly caving, with a consequent decrease in the tonnage mined, systematic packing of the stoped-out areas, as stope faces advanced, was adopted with excellent results such as had been obtained several years previously in the outcrop section. Various methods of packing have been adopted according to the particular conditions. The authors begin by describing the method of packing in typical Main Reef Leader machine stopes of an average stoping width of 75 in. In this class of stope the hanging wall is usually so bad as to necessitate packs being built within from 6 to 8 ft. of the machine benches. The packs are built of broken ore from the current stope faces, and are supported in the first instance by timbers and lagging poles as shown in Fig. 1. The foundation

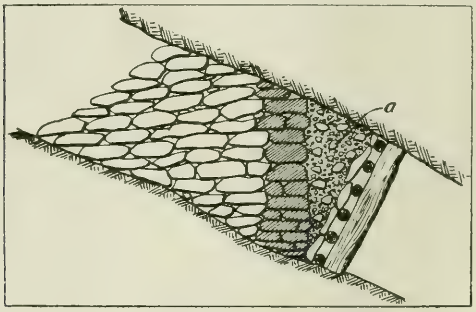


FIG. 1. CROSS SECTION OF PACKING.

timbers are about 10 in. in diameter and 10 ft. apart, carefully placed in hitches, but without headboards. It is essential that these timbers should be set in such a way as best to withstand the shock from blasting, which would be impossible were headboards employed. Lagging poles, 12 ft. long by 3 in. in diameter at the small end (old pipes or rails are also used) are placed across the timbers, beyond which they project about 1 ft. The lagging poles are placed about 12 in. apart to allow for wings being built on to the pack, a wing being a lateral extension to the original pack formed by placing lagging poles over one of the stull posts of the original pack between the ends of its lagging poles and over a new timber placed as required; thus the pack foundation is widened and packing continued off the new extension. An important point in the actual stonewalling operations, when building packs of this type, is that care should be taken in building the back-wall of the pack, shown hatched in the figure. This wall must be so built that, when the timbers and lagging poles fail or are removed, only the filling falls away. The advantages of this type of pack are: (1) timbers and lagging poles can be withdrawn and used over again: (2) if, due to pressure or blasting, timbers become broken or fail, only the filling falls away, and the main pack still supports the hanging wall. It is essential, in building packs of this type, that the back and retaining walls are commenced with the main foot-wall as a foundation, and not built on loose, broken rock. The retaining wall farthest from the stope face should at all times be built up ahead of the one nearest the face. This saves time and cost in packing, as the rock from the blast is shot into the pack. In this way the actual packing operations consist of carefully building the walls of the pack, the centre being filled with loose rock, mostly through the medium of the blast. Packs of this type are found most satisfactory in stopes where heavy blasting is done. This can be adopted most successfully in stopes dipping at angles from 10° to 35°. The maximum angle of dip suitable would depend on the nature of the foot-wall, and is governed by the question of safety, for in the event of the timbers falling away where the dip is too steep, the rock might roll down the stope and be a source of danger. Generally speaking, in stopes dipping steeper than 35°, a pigstye foundation for the pack is safer. Solid ground is sometimes used as a pack foundation.

Another type described by the authors is the packing in Main Reef Leader and South Reef stopes of an average stoping width of 66 in. The stoping in this class of stope is generally done by small machines or hand labour. The blasting is, therefore, not so heavy as in stopes where the type of packing used is that first described, and modifications of this type of packing are employed with a view to the saving of time and timber. Originally pigstyes were used either alone or as a foundation for packing. The pigstyes were built either of a square or round timber 8 ft. long by 5 in. thick, square timber being the easiest to handle in steeply inclined stopes. The foundation on which a pigstye is built consists of two lagging poles set as stull pieces, and by the time these poles are broken by the subsi-

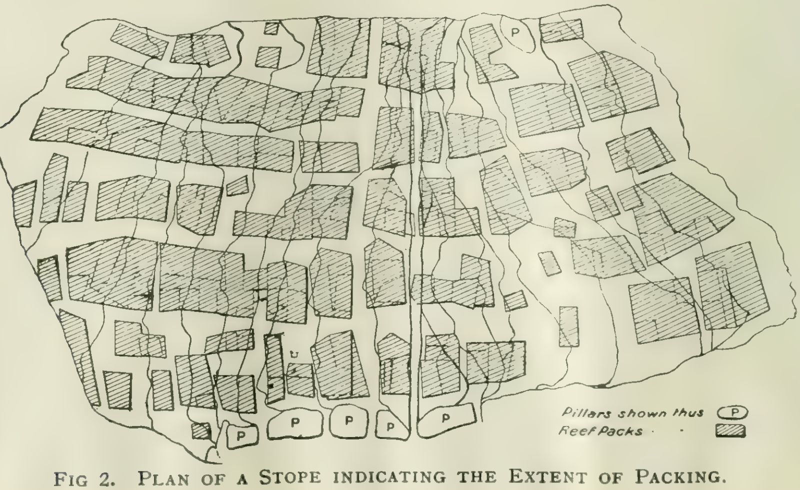


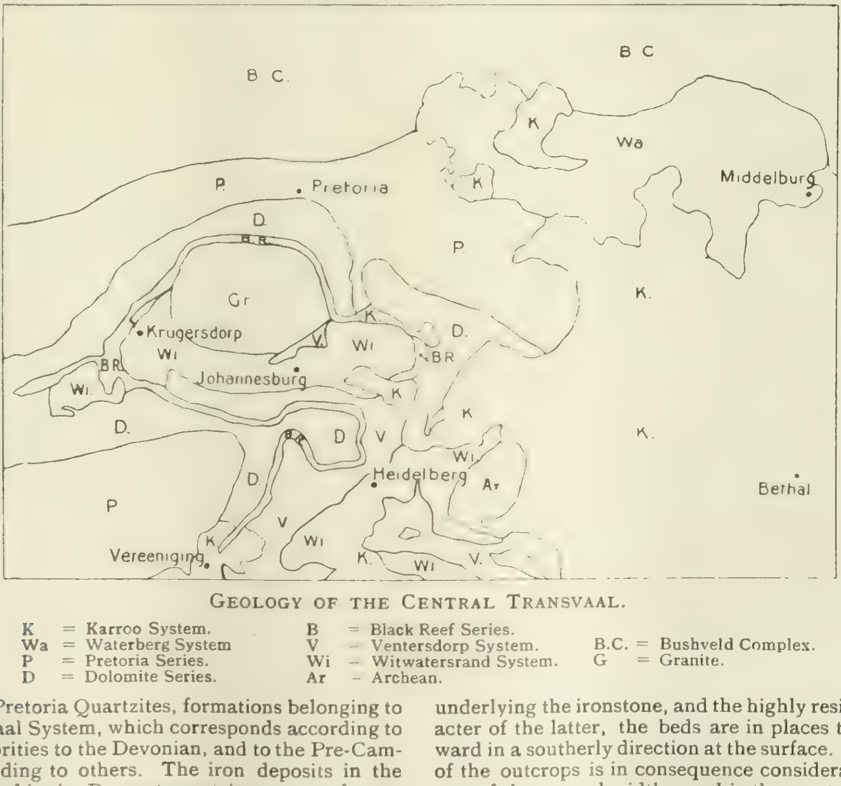
FIG 2. PLAN OF A STOPE INDICATING THE EXTENT OF PACKING.

dence of the hanging wall, the pigstye has been tightened sufficiently to stand by itself. When pigstyes are built near the stope faces they are either filled in with broken ore or waste rock, and on the side nearest the stope face broken ore is stacked to act as a buffer against blasting, and thus prevent the pigstye, before it has become tightened by weight, from being blasted out. Occasionally the pigstye is tightened in position by the use of wooden wedges. Recently packs have been substituted for pigstyes to save timber. The type of pack used in this case is a modified form of the pack already described, short lagging poles in some cases being substituted for the timbers, and in other cases a back-wall is built up either off a suitable foundation on the foot-wall or off a lagging pole, old pipe, or rail laid across two jumpers placed in holes drilled in the foot-wall. Packing in close proximity to the working face, and therefore subject to blasting, requires to be done with more care than packing away from the vicinity of blasting.

As regards the area covered by packs in the Main Reef Leader stopes packed according to the first method, from 42% to 70% of the area stoped out was covered by packs during 1916. In the South Reef stopes the area packed varied from 32% to 66% of the areas stoped during the same period. The authors also describe the method adopted for eventually reclaiming the ore in the packs.

IRON ORES IN PRETORIA DISTRICT.

Messrs. Percy A. Wagner and G. H. Stanley have written a report for the Pretoria Municipality on the iron ore deposits found on the town lands in that district. This report is reprinted in the *South African Mining Journal* for July 14 and 28, August 4 and 18. We make lengthy extracts herewith. There are four distinct iron horizons near Pretoria, in the Dolomite and in the Pretoria Quartzites, formations belonging to the Transvaal System, which corresponds according to some authorities to the Devonian, and to the Pre-Cambrian according to others. The iron deposits in the Dolomite and in the Dasport quartzite are not of economic importance. The deposit of highest grade is the "clay-band" above the Timeball Hill quartzite, but larger amounts of ore of slightly lower grade are found lower in the Timeball Hill zone. The latter are described first.



GEOLOGY OF THE CENTRAL TRANSVAAL.

K = Karroo System.
Wa = Waterberg System
P = Pretoria Series.
D = Dolomite Series.
B = Black Reef Series.
V = Ventersdorp System.
Wi = Witwatersrand System.
Ar = Archean.
B.C. = Bushveld Complex.
G = Granite.

Timeball Hill Ores.—The so-called magnetic quartzite of the Timeball Hill zone occurs in two main beds of remarkable persistence that outcrop conspicuously in the hills immediately south of Pretoria. The beds are conformably interstratified with the Timeball Hill quartzites and shales, being separated by from 95 to 150 ft. of shale. The upper is the more important of the beds. It ranges in thickness from 9 to 20 ft., the average being about 12 ft. The lower bed appears to average about 4 ft. in thickness, the maximum being 6 ft. Owing to the rapid removal by weathering of the soft shale underlying the ironstone, and the highly resistant character of the latter, the beds are in places tilted backward in a southerly direction at the surface. The width of the outcrops is in consequence considerably in excess of the normal widths, and is thus apt to give an erroneous impression of the thickness of the ore. As a consequence of the powerful faulting that has affected the Transvaal System in and around Pretoria, the Timeball Hill zone is duplicated over a considerable distance, with the result that the amount of iron ore within the municipal area is enormously greater than it would otherwise be. Thus, the actual lengths of outcrop, on the Pretoria Town Lands, of the upper and lower beds of ironstone respectively, are about 21½ and

21 miles. The beds dip to the north at an average angle of about 35°, and without doubt persist to far greater depths than are likely ever to be attained in mining. They underlie practically the whole of the Town Lands north of the Klapperkop Range, and the upper bed would, for example, be struck below Church Square at a depth of roughly 3,600 ft. The reserves of ore in the two beds are thus for all practical purposes inexhaustible.

The Timeball Hill ore in its typical development is best described as an arenaceous oolitic ironstone, the designation of magnetic quartzite commonly applied to it being wholly inappropriate. It is a fine-grained, hard, feebly magnetic rock of deep reddish-black colour, composed of small grains of quartz set in an abundant matrix of iron oxides. The relative proportions of quartz grains and matrix vary considerably at different points. In places the quartz appears to be uniformly distributed through the rock, but as a rule the ironstone is more or less distinctly banded, being made up of alternations of quartz-rich and quartz-poor layers. The quartz grains range in diameter from 0·85 to 0·05 millimetres. They are for the most part sub-angular, though perfectly rounded grains are by no means uncommon. Under the microscope the dark matrix is seen to be composed largely of small ellipsoidal, or more rarely spherical, oolitic grains, varying from 0·28 to 0·13 millimetres in diameter. These consist, as a rule, of a nucleus, either a minute granule of quartz or a sphere or ellipsoid of a deep brownish-red translucent substance, surrounded by alternations of thin concentric layers of black, lustrous martite and the brownish red substance already referred to, and a thicker outer rim of martite, in which a radial structure is frequently developed. In the deep brownish-red substance entering so largely into the constitution of the oolites, and which is evidently composed largely of iron oxide, minute flakes of green pleochroic chlorite can occasionally be made out, and where, as is sometimes the case, the mineral preponderates, the nuclear portion of the oolites has a greenish-red colour. The oolites were evidently formed by the deposition in shallow water, strongly agitated by waves and shore currents, of successive layers of ferruginous mud around particles of quartz or minute pellets of clay.

Scattered indiscriminately through the quartz-rich and quartz-poor layers of the rock are sharp-edged octahedral crystals of martite. These replace oolites as well as quartz grains, and are frequently developed in the peripheral portions of the latter. They evidently owe their origin to the re-crystallization of portion of the iron content of the rock, the martite being probably pseudomorphous after magnetite. The interstices between the oolites and between the quartz grains, where these happen to be in contact, are occupied by iron oxides and flakes of chlorite. So firm and strong is this cement that the rock on being crushed breaks indiscriminately across quartz grains and matrix. This, together with the fact that the larger quartz grains are almost invariably in contact with the iron-rich peripheral portions of the oolites, or with crystals of martite, renders it impossible effectually to separate the quartz from the iron minerals by crushing. It was found, for example, that even after the ore had been ground to pass through 200 mesh most of the quartz grains still had particles of iron oxide adhering to them and vice versa, which serves to explain how it is that the concentrate obtained by magnetic or wet separation invariably contains a fairly considerable percentage of silica, and the tailing a good deal of iron.

The iron content of the rock ranges from 40·5 to 53·6%, some sections of the beds being richer than others. A series of samples taken along the outcrop of the upper bed on the Muckleneuk Hill, between Groenkloof and Fountains roads, showed iron contents ranging from 48·6 to 53·6%. None of the samples were thoroughly representative, but the results of the analyses none the less indicate that it would be possible by careful mining to maintain a grade of close on 50% along this particular stretch. A sample from the central portion of the upper bed as exposed in the old Municipal Quarry on the Johannesburg road also assayed over 50% of iron. In the Fountains Quarry, on the other hand, the iron content of the upper bed, which is here about 15 ft. thick, appears to vary from 40·5 to 45·5%. The complete analyses of two of the samples of the upper bed were as follows :

	Ironstone of the Upper Bed, Groenkloof Road. %	Ironstone of the Upper Bed, Fountains Quarry. %
SiO_2	17·44	21·96
TiO_2	Trace	Trace
Fe_2O_3	69·43	65·57
Al_2O_3	7·38	6·54
CoO	0·75	1·20
MgO	0·47	0·44
P_2O_5	0·39	0·55
Loss on Ignition	4·30	3·70
Total	100·16	99·96
Fe	48·6	45·9
P	0·17	0·24
S	0·014	0·015

The specific gravity of the ironstone of the upper bed varies with its iron content from 3·8 to 4·21. The mean for a number of specimens was found to be 3·96 ; so that an average of 8·1 cubic feet of the ore make up a short ton. Of the lower bed only one sample was examined. It was taken from an outcrop on the Muckleneuk Hill, some little distance above Groenkloof road, and assayed 51·4% of iron.

The ironstone, as previously indicated, is highly resistant to the atmospheric influences. It breaks up slowly at the surface into fragments, ranging up to 6 and even 9 in. in diameter, which accumulate in the neighbourhood of the outcrops and on the hill slopes, becoming gradually rounded in the course of time. The iron content of this material, to which the name "rubble ore" may be applied, varies from 48 to 54%. It occurs in sufficient quantity to be of considerable economic importance.

The amount of ore available in the ironstone beds of the Timeball Hill zone is, as already stated, practically unlimited. An enormous tonnage is, moreover, capable of cheap open-cut and adit mining in the hills to the south of the town. In the Muckleneuk range, for example, between Fountains and Groenkloof roads, the upper band above the level of Groenkloof road contains, according to a conservative estimate, about 3,000,000 tons of ore. Of this quantity 500,000 tons could be quarried in open-cuts and loaded into trucks at a cost of 3s. 6d. per ton, while the remaining 2,500,000 tons could be recovered by adit mining at a cost of 6s. per ton. The lower bed within the same limits contains some 1,200,000 tons of ore. The tonnage available in the Klapperkop and Timeball Hill ranges is enormously greater than in the small Muckleneuk range, and in addition there are millions of tons of rubble ore on the hill slopes. This could be gathered and separated from the accompanying waste by hand-picking on travelling belts, at a cost certainly not exceeding 4s. per ton. There is, therefore, enough ore capable of being cheaply mined on the Town Lands, in this one horizon, to keep a large blast-furnace plant supplied almost indefinitely.

The quantity of ore available at or near the surface being so enormous, the question of whether or not there is likely to be any depreciation in iron content at depth is of no great moment. It may be pointed out, however, that while it is possible that there may be changes in mineralogical composition, the general character of the ironstone is such as to render it very unlikely that there will be any marked falling off in the amount of iron that it contains.

The "Clay-Band."—The "Clay-Band," a thin bed of hard argillaceous ironstone intercalated with the shales overlying the Timeball Hill zone, outcrops intermittently over a distance of fully eight miles. It probably extends right across the Town Lands from east to west, and is, like the Timeball Hill bands, duplicated over a considerable distance. As the clay-band contains the best iron ore within the municipal area, it is desirable that prospecting pits should be put down at regular intervals all along its probable strike in order to settle this important point. The bed is well exposed to the north and east of the Forester's cottage to the south-east of the Groenkloof Plantation, where a prospecting pit was recently put down at the suggestion of Mr. T. G. Trevor. It has a thickness of 2 ft. 4 in., but owing to its very low dip, about 10°, the outcrop is in places fully 60 ft. in width. The ironstone, a fine-grained. reddish-brown, brown-weathering rock, is much cut up by joints. Along some of these a concentration of limonite has taken place, probably by capillary attraction. Others are occupied by quartz veins. These range up to 1½ in. in thickness, and the quartz could easily be eliminated by roughly sorting the broken ore. Three samples of the rock from this locality were submitted to chemical analysis. The first of these, a general outcrop sample, was found to contain 52·5% of iron. The second, a sample taken from the prospecting pit already mentioned, assayed 51·5%. The third, taken from an exposure of the bed in a deep donga some hundreds of yards to the east, assayed 46·5%. This sample, however, was not taken across the full stoping width, and it is probable, moreover, that at this particular spot some of the iron has been leached out of the rock. The complete analysis of No. 2, a fairly representative sample, was as follows. It is a recalculation of the analysis disregarding water, carbon, dioxide, etc.: SiO_2, 7·70%; Fe_2O_3, 73·57; Al_2O_3, 7·94; CaO, 0·45; MgO, 0·33; P_2O_5, 1·19; loss on ignition, 8·60; total, 99·69; Fe, 51·5; P, 0·52; S, 0·029.

The results of this analysis prove the ore to compare very favourably with the best grades of clay iron ore worked in Europe, America, and India. Thus the clay ironstone of the Raniganj coalfield, which affords the basis of the Bengal iron and steel industry, contains only 43·4% of iron and 16·4% of silica. The specific gravity of the clay-band ore is 3·5, so that 9·18 cubic feet go to a short ton. What the precise nature of the ore will be at a depth is uncertain. Judging by the character of its outcrop, it appears not improbable that there has been a superficial enrichment of iron, or, in other words, that there will be some slight falling off in iron content at depth, but this can only be determined by actual underground development. The clay-band also outcrops conspicuously to the west of Pretoria, some little distance beyond the Police Camp. The thickness here appears to range from 18 in. to 2 ft. 6 in., and as the dip is steeper the width of the outcrop is much less than in the Groenkloof Plantation exposures. A general outcrop sample, composed of fragments of the rock knocked off at random, assayed 55·2% of iron. This is somewhat in excess of the average grade.

Notwithstanding the inconsiderable thickness of the clay-band, conditions are on the whole favourable to its cheap exploitation. In the first place, a fairly considerable tonnage of ore is actually exposed at the surface. This could be quarried and loaded into trucks at 4s. per ton. Secondly, owing to the low dip of the bed in some localities, as, for example, to the south of the Groenkloof Plantation, a further large supply could be rendered available for cheap open-cut work by stripping the overlying shale with a steam shovel. Finally, owing to its occurrence as a hard bed intercalated with soft shales, the ore could be cheaply and cleanly broken underground by resuing methods, and underground mining costs should not exceed 10s. per ton.

Owing to the lack of adequate exposures, it is impossible to give even an approximate estimate of the tonnage of clay-band ore available within the municipal area. As the bed actually runs for a considerable distance through the southern part of the town and suburbs, only a portion of it will be accessible to mining. Assuming, however, that it can only be worked over a distance of 10 miles, and taking the average thickness of the bed at 18 in., then the amount of ore available within 500 ft. of the surface, measured along the dip of the bed, would be over 4¼ million tons, enough to keep a blast-furnace producing 200 tons of pig-iron per week supplied for over 200 years.

The authors proceed to discuss methods of smelting the ore. As already mentioned, it is impossible to obtain a clean separation of the iron and silica by concentration, so the ore will have to be smelted direct. As regards fuel, no coke is available at a reasonable price at present, so it is recommended that charcoal be used, in a furnace producing 100 tons of pig-iron per week.

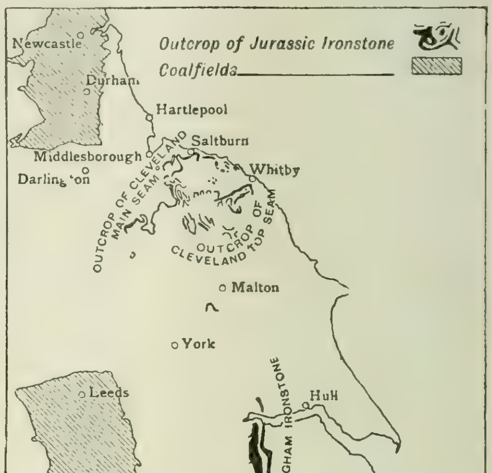
BRITISH IRON ORE RESOURCES.

Last month we discussed, in an editorial, the present resources of iron ore in this country, pointing out that the immense amounts of phosphatic ironstone in the Lias and Oolite constituted our most important reserve. The subject has created so much interest among readers that we here expand on it, by quoting extracts from a series of lectures delivered before the Royal Society of Arts by Professor W. G. Fearnsides, of the University of Sheffield. We reproduce one of his maps, giving the outcrops of the Lias ironstone from Yorkshire to Oxfordshire. In our editorial we mentioned that the hematite of North Lancashire and Cumberland is the ore of highest grade, and that other iron ores came from the Coal Measures, but that the first is limited in amount and the second in applicability. Professor Fearnsides sums up as follows: "Just as the Carboniferous is the great repository of Great Britain's fuel wealth, so the Jurassic is the bank which holds our fluid reserve of iron ore. The gilt-edged securities of Cumbrian hematite are sound, but not unlimited in amount; while the market for the vast quantities of the clay-band and black-band ores of the Coal Measures is so limited that as a security they must needs be written off. Our engineers prefer the produce of the hematite, but there is a shortage, and the price is therefore high. There is plenty of the low-grade phosphoric ore available and cheap. Surely it is not beyond the skill of our metallurgists to make use of it, and obtain from it a product which on its merits will overcome the prejudice of the British engineers. This is the only domestic solution of the problem of the home shortage of non-phosphoric iron ore."

We extract in the following paragraphs some of Professor Fearnsides' notes on the Jurassic deposits extending from North Yorkshire to Wiltshire, according to the counties in succession.

Yorkshire.—First among the counties as a producer of iron ore stands Yorkshire, which, by reason of the productivity of the Cleveland district, has maintained the premier position in this respect for more than fifty years. The working of the Cleveland Main Seam, which forms the topmost bed of the *Spinatus* zone of the Middle Lias, only began about 1850, but by 1856 the tonnage wrought exceeded a million tons a year, and in 1876 the year's output had grown to more than six million tons. The maximum productivity of the Cleveland district was attained in the early eighties, with 6,756,055 tons in 1883, since which date until 1915 the yearly output has never fallen below five million tons, so that the total tonnage won has passed 300 million tons. The ore bed is at its thickest (about 17 ft.) in the district where it was first opened up at its outcrop near Eston Nab. Down the dip and along the outcrop the thickness varies somewhat irregularly, but on the average it becomes thinner in an easterly and southerly direction. Over a total area computed at about 350 square miles there is said to be an average of more than 6 ft. of workable ore. South of a line joining Robin Hood's Bay to Thirsk, inconvenient partings of hard shale come in in the middle of the ore, and subdivide the seam, so that in all the district south of Kildale the seam is so split up that the working of it is unprofitable. Some five-and-twenty mines, employing nearly ten thousand men, are now at work in the northern district. Underlying the main seam, and separated from it by a hard shale which varies from little more than a parting to a rock mass several feet thick, occurs the *Pecten* seam, which is of greatest economic interest in Southern Cleveland about Grosmont and Rosedale, where the main seam is so split up by partings as to be unworkable. In addition to the ironstones of the Middle Lias series, the basal bed of the overlying Bajocian series, known as the Cleveland Top seam or Dogger ironstone, has on occasion been worked along the valley of the Esk. In former days this seam proved specially valuable in the Rosedale mines, where it was known as the seam of the district. Generally, however, its ore is too silicious to be much in request among Cleveland ironmasters.

As mined, Cleveland ore is generally a blue or green-grey oolitic rock, in which the carbonate of iron occurs as oolitic grains. In the analyses silica is shown to form at least 8%, and on occasion up to about 20% of the rock, but the bases, more especially lime and alumina, are also present in such proportion that the ore is almost self-fluxing. The sulphur percentage is not high, averaging about 0·1; but phosphorus is moderately abundant, and if the pig-irons which Cleveland ore yields when smelted with Durham coke are to be made into steel, the basic process is needed for its refining. It is worthy of note that the Thomas-Gilchrist basic process, which is the basis of all modern German practice of steel-making from pig-irons smelted from Lorraine ores, was invented and perfected at Middlesbrough between 1877 and 1881 for the purpose of converting Cleveland pig-iron into steel. In Great Britain the process has been taken up much more slowly than on the Continent, partly because our engineers are conservative in their practices and have been very suspicious of the reliability of any except acid steel, and partly because in this prejudice they were encouraged by ironmasters who had vested interests both in the plant required for carrying on the acid process and in the mines from which hematite ore is wrought. In 1910 Professor Louis estimated the available ore reserve of Cleveland at 3,000,000,000 tons.



OUTCROPS OF JURASSIC IRONSTONE.

Lincolnshire.—This county has no coalfield within its borders, but with the development of the railways needed to carry surplus production of coal from the Yorkshire, Derbyshire, and Nottinghamshire coalfield to seaboard for shipment, facilities for bringing fuel to the ironstone or taking ironstone to meet the fuel have in recent years improved, and the iron-ore output of the country has found a ready market. Since the war the tonnage of ore wrought in Lincoln has increased considerably, and the county has advanced to second place. Rocks older than the Mesozoic have no outcrop within the county of Lincoln, and the various ironstones there worked are all of Jurassic age. Most productive among them are certain beds of shelly ironstone interbedded with the limestones of the *Semi-costatus* zone about the middle of the Lower Lias, in the Frodingham district of North Lincolnshire just south of the Humber. The thickness of the beds worked is in places as much as 25 ft., and though the iron content of the ore is low (only 25·6% on the average), the low dip of the measures and the character of the topography of the district allow it to be worked by open-cut for over a mile in from the outcrop, and a large tonnage of ore can therefore be won cheaply. The circumstance that the calcareous impurities are such that to some extent this ore can be used as a flux in smelting more silicious ores makes it a valuable national asset. By boring, the Frodingham or Scunthorpe ironstone beds have been proved to extend eastward down dip for several miles, and, unlike the Bajocian ores of Northampton, they do not seem to be inferior in quality where proved under considerable cover. The ore reserve was estimated by Professor Louis in 1907 at 100,000,000 tons. Some sixteen quarries working in North Lincolnshire in 1914 employed over 1,000 men.

Rutland.—The ores of Rutland are quarried from the northward continuation of the outcrop of the basal Bajocian ore bed of Northamptonshire, which is being worked between Cottesmore and Market Overton. The ores from this district are somewhat more silicious than the average of the equivalent ores of Northamptonshire.

Leicester.—The ironstone of Leicestershire is the immediate continuation of the Marlstone belt of the Middle Lias, which occurs in the Grantham district of south Lincolnshire, and extends south-westward along the ridge overlooking the Vale of Belvoir as far as Wartnaby, near Melton Mowbray. The chemical characteristics of the ironstone district are said to be like those of the Cleveland Main Seam, but, being as yet only worked in shallow quarries along the outcrop, it is sent to furnace in a considerably more oxidized and weathered state. The metallic iron yielded is only 27·45%. Ironstone quarrying in Leicestershire only began in 1881, but by 1890 the output had advanced to nearly one million tons per year.

Northampton.—Being separated by a considerable distance from the coalfields, the development of the iron industry of Northampton suffers under the handicap of considerable freight charges; but the low price at which the thick ironstone bed which forms the basal bed of the Inferior Oolite or Bajocian series within this county can be worked has, since the eighties, enabled it to vie with Lincoln for second place among the counties as a producer of iron ore. The Bajocian ore-bed extends in some form or other from Steeple Aston in Oxfordshire, along the whole length of Northamptonshire, northward almost to Lincoln; but at present the active workings are situate to the north of the London and North-Western Railway main line from Rugby to London, and south of the River Welland. Like the geologically contemporaneous Cleveland Top bed or Dogger ironstone of Eskdale in Yorkshire, mentioned above, the Northamptonshire ironstone is distinctly a silicious ore, and where, in the deeper levels, the oolitic grains which are characteristic of the unweathered ore remain, the ore is sometimes so silicious as to be unsuitable for smelting. Some forty-five quarries and seven mines, employing 2,500 men, were active in Northamptonshire in 1914. The proportion of quarries to mines is characteristic of the relatively high esteem in which the weathered material from near the outcrop is held by the ironmasters who are purchasers of the ore.

Fortunately the ironstone district of Northampton is a region of considerable topographical relief, and as the dip of the measures is slight, the area over which outcrop material is available for working by open-cut is considerable. Professor Louis has estimated the potential ore reserves of the Northampton ironstone district at 1,000,000,000 tons, but there will have to be some improvement of metallurgical processes before the unweathered carbonate ore, rich in silica, as found in depth, can enter into economic competition with the more concentrated and less silicious weathered ores. The average ton percentage of the ore won in 1915 was 32·4. The working of iron ore in Northampton only began in 1851, and the output attained 1,000,000 tons per year in 1871.

Oxford.—The ore wrought in Oxfordshire is obtained from shallow quarries along the outcrop of the Marlstone beds of the Middle Lias, which, between the valleys of the Cherwell and the Evenlode west of Banbury, forms an extensive dip-slope and culminates in the escarpment of Sunrising and Edge Hill, just over the county boundary in Warwickshire. The quality of the ironstone of the Banbury district is similar to that wrought in Leicestershire, and it is said that only the unfavourable disposition of the railways which carry the ironstone to meet the fuel has prevented the development of the Oxfordshire ore quarries on a like scale to those in the district north of Melton Mowbray.

Wiltshire.—Notwithstanding its remoteness from other centres of the iron industry, the Westbury iron industry continues to exist, and smelts ore from an 8 ft. ironstone bed which underlies the Kimmeridge clay and is a local development of the highest beds of the Corallian series. The Westbury ore is somewhat silicious, but, carrying on the average about 30% of iron, is richer than the average of British Jurassic iron ores. Similar ore bodies are developed sporadically along the outcrop of the Corallian series southward as far as Abbotsbury on the Dorset coast. The Lower Greensand ironstone, until recently worked at Seend, about halfway between Bradford-on-Avon and Devizes, is a sort of hard-pan or caratone concretionary ore which has probably been formed by the concentration of products formed from the oxidation of glauconite. Except where the sandy matrix in which the hard-pan lies is so loose that it can be removed by screening, the Seend ore is too silicious for general blast-furnace purposes.

Estimation of Tin.—In the *South African Mining Journal* for August 25, Alfred Adair describes two new methods for estimating tin in low-grade ore, tailing, and slime. The description is in parts not quite clear, and the reasons for some of the instructions are not always obvious. We consider it best to follow the author's own wording as far as possible, leaving our expert readers to gather the essential points of the new processes and make their own deductions.

The author prefatorily remarks that the sodium peroxide, or indeed any fusion method, yields such excessive amounts of gelatinous silica that the separation of the tin therefrom becomes impracticable. Evaporation with hydrochloric acid, to render the silica insoluble, results in the loss of the greater part of the tin as stannic chloride. The two new methods given by the author depend on converting the stannic oxide into tin or its phosphide without fluxing the gangue. The metal is then dissolved and easily separated from the non-gelatinous silica.

The first method described employs zinc dust. The ore is ground to the finest powder in a porcelain mortar until it cakes; it is then intimately mixed with two-fifths its weight of good zinc dust and one-fifth powdered charcoal, and gently shaken down into a porcelain crucible. The charge is covered with a layer of small charcoal, with a larger piece to form a central core round which the charge is packed, and covered over with charcoal dust, and finally the loose lid. The charge must be rapidly headed to volatilize the zinc quickly and for fifteen to twenty minutes. The author uses a kerosene blast lamp, and jackets the crucible; when finished, the flame is extinguished, but the hot vapour is played about the crucible to cool it below the ignition point of the charcoal. When cold, the surface of the charcoal is examined; if it shows a white incrustation some of the finely divided tin has been volatilized. A little experience is necessary to determine the temperature; if too low, the reduction is incomplete; if too high or too long continued, tin is volatilized. The fine powder is now transferred to a flask provided with an arrangement for generating carbonic acid and preventing access of air. 25 c.c. or more of hydrochloric acid, that has been previously boiled and warmed for 1½ hours with a piece of platinum, is added. On first shaking up with the acid, the finely divided white tin shows at the bottom of the flask; later any unattacked stannic oxide. When solution is complete, the gangue, etc., is filtered off and washed, and the tin estimated gravimetrically or by titration with standard ferric chloride, KSCN being used as indicator. In the cold this method is unsatisfactory, but titrated boiling hot, it is surprisingly accurate and sharp; 1 c.c. gives a clearly defined end reaction from colourless to yellow. Strength of $FeCl_3$: 1 c.c. = 0·01 Sn or 0·00941 $FeCl_3$.

In the second, or phosphide, method the ore is roasted sweet or treated with nitric acid and washed free from pyrite. As before, it is ground to impalpability, mixed with two-fifths dry ammonium phosphate and one-fifth charcoal, both finely powdered, and all well mixed. For 5 grams of ore, take a C annealing cup and deftly grind a lid to it with a little fine sand, until it closes all round. The inside is wetted and rubbed with powdered blacklead to get a good coating for polishing when dry. The crucible is dried and polished and charged with the mixture, which is gently shaken down and then dusted over with charcoal powder, and the lid placed with a small weight to keep it down. A kerosene blast lamp and jacket are used, first heating gently for ten minutes and then at a red heat for half an hour, cooling off with the vapour of the lamp as before. When cool, the mixture will be found to have sintered a little, but is detached from the crucible, which can be used again and again. The charcoal is blown off and the ignition transferred to a porcelain crucible and ground to the finest powder. It is transferred to a flask as before and wetted with alcohol to make it take the acid, 25 c.c. of boiled HCl, and left in a warm place overnight, by which time the tin is in solution and easily filtered from the gangue and charcoal.

The reaction with stannous chloride is $SnCl_2 + 2\ Fe_2Cl_3 = SnCl_4 + 2\ FeCl_2$, which is rapid and complete at about 100° C. in the presence of an excess of hydrochloric acid. 10 grams of a fairly fine iron and 11 of potassium chlorate are dissolved in hydrochloric acid and evaporated on the water bath to remove the excess, but no further. The salt is dissolved and filtered and made up to 500 c.c. To standardize, roll out fine tin to foil, clean from grease, and polish with fine sandpaper. With a pair of sharp scissors, cut off the finest possible clippings and weigh out 0·1, 0·15, and 0·25 grm. While this is doing, dilute 250 c.c. of hydrochloric acid to 500 c.c. and boil for 20 minutes or until a milligram or so of very fine iron wire dissolves in a test tube without yellow coloration. It is kept in a stoppered bottle with a beaker over it to keep out the dust. 50 c.c. of the acid is placed in a conical assay flask provided with a small funnel. The acid is heated on a hot plate to boiling for some time, to drive out air, and the tin clippings added with precautions to avoid spurting. Tin dissolves slowly in any case, but if greasy and thick it takes hours. When dissolved and still boiling hot, the standard is run in rapidly, 8 c.c. for 0·1, and then by 1-10ths c.c. until the change of colour is permanent. Water is then added to make 1 c.c. = 0·01 gram Sn, and further checked with the other weighed portions of tin. The change of colour can be easily seen by placing white paper or a tile under the flask, or still better by transferring to a clean hot basin and stirring. The change from colourless to yellow is quite distinct with two drops of the standard on pure tin, but in ores it is better to work for an excess of, say, four drops, so as to be quite sure. The results are not reliable in the cold. The solutions must always be near boiling and have a large excess of acid. To prepare the ore solutions for this titration, the ore after filtration is received in a conical assay flask containing very fine iron wire, iron wire being also placed in the funnel. The solution is sure to contain stannic chloride, which volatilizes very easily if the solution is yellow. It is therefore not warmed until colourless. Then it is carefully warmed, adding reduced iron and a large excess of iron wire. It is best to have two grades of wire, one as fine as hair, and the other pin-wire thickness, ½ gram of each to each assay. When the gas bubbles from the fine wire cease to be absorbed and give the solution a milky appearance (this gives the highest result on titration) the excess wire is fished out. Results on a sample of ore containing 1⅓% SnO_2: Zinc dust method: 11 successive results, 1·00 to 1·40, mean 1·20%. Phosphide method: 7 successive results, 0·88 to 1·28, mean 1·21%.

Nitric Acid from the Air.—The American Committee on Nitrate Supply has issued a report by Dr. Charles L. Parsons on the methods of fixing atmospheric nitrogen. This contains an excellent survey of the present position. We reviewed the subject before the war, in our issue of June, 1913, and we mentioned then a new process known as the Haber and adopted by the Badische Anilin und Soda Fabrik. At the time, the process consisted of uniting nitrogen and hydrogen as ammonia, under pressure, and in presence of a catalytic agent such as osmium. Since then iron has been substituted for osmium. We quote in the following paragraph Dr. Parsons' remarks on this process, but we would say that its most important use at present is not the production of ammonium sulphate fertilizer but the manufacture of nitric acid for war purposes by treating the ammonia by the Ostwald process. In fact it is the main basis of German explosive supply.

The Haber is the chief process now used in Germany for the production of ammonia. The process has grown rapidly in the last three years. It was first commercially installed in Germany in 1913 with a plant capacity of 30,000 tons of ammonium sulphate. It actually produced in that year 20,000 tons of ammonium sulphate. This grew to 60,000 tons in 1914; 150,000 tons in 1915; and 300,000 tons in 1916; and it is authoritatively stated that with new works constructed by the Badische company, the 1917 output of ammonia will be equivalent to over 500,000 tons of sulphate. By the process, nitrogen from the air and hydrogen obtained from water are directly combined to form ammonia under the influence of finely divided iron. The production and purification of hydrogen made either by the reducing action of coal or iron upon steam involves one of the chief items of cost in the process. The fact that the combination of nitrogen and hydrogen takes place at temperatures above 500° C., and at pressures of 125 to 150 atmospheres, involves some danger and many other technical difficulties which have, however, apparently been overcome in Germany. The control of the process requires so high a degree of training and skill that it is reported if the Badische people were to lose their present technical staff of experts, familiar with the process, many months would be required to train another staff capable of applying the process in practice. The process is not at present in use anywhere outside Germany on account of the lack of detailed information regarding plant construction and operation, and also owing to the very large royalty demanded by the Badische company for its use by other concerns. It is, however, more than probable that the Badische company will itself install and develop the process outside Germany when the war is ended. Trustworthy information regarding the costs of production of ammonia by the process indicates that pure anhydrous ammonia can be produced in liquid condition for a cost slightly less than 4 cents per pound. It is the cheapest process for the production of synthetic ammonia. It is independent of cheap power, the power being a small fraction of its cost. If desirable, it could be readily installed in moderate-sized units in connection with ammonia oxidizing plants at any munitions plant.

Copper Output in 1916.— *The Engineering and Mining Journal* for September 22 contains the editor's revised figures for the production of copper throughout the world during 1916. These are given in Table I together with those for 1915. The basis of the estimates

TABLE I. OUTPUT OF THE WORLD.

Country	Metric Tons. 1915	1916
United States	646,212	881,237
Mexico	30,969	55,128
Canada	47,202	47,985
Cuba	8,836	7,816
Australasia	32,512	35,000
Peru	32,410	41,625
Chile	47,142	64,636
Bolivia	3,000	4,000
Japan	75,415	81,280
Russia	34,918	31,500
Germany	35,000	45,000
Africa	27,327	34,572
Spain and Portugal	46,200	42,000
Other Countries	25,000	25,000
Totals	1,092,143	1,396,779

is the output of crude copper at the smelters, and not the yield of ore at the mines. Thus some Canadian, Peruvian, and Chilean copper is included in the United States output, but how much is not ascertainable. We give also the United States' outputs by states. These figures are in pounds, the total 1,942,776,309 corresponding to 881,237 metric tons in Table I. The figures in these two tables indicate the big advance in the United States output during 1916, and also the tremendous proportion of the world's copper coming from the United States and other parts of the Western hemisphere.

TABLE II. OUTPUT IN THE UNITED STATES.

State	Output in Pounds. 1915	1916
Alaska	72,621,844	115,933,315
Arizona	444,089,147	692,630,286
California	37,935,893	51,358,334
Colorado	8,126,000	9,802,183
Idaho	5,602,000	6,741,001
Michigan	241,123,404	270,058,601
Montana	268,027,557	351,995,058
Nevada	66,394,906	100,143,431
New Mexico	75,515,138	83,013,805
Utah	180,951,174	225,396,808
East and South	18,858,677	20,018,261
Other States	4,452,420	15,685,226
Totals	1,423,698,160	1,942,776,309

Lode Tin in Billiton.—Little information is ever published of the tin-mining operations on the islands of Billiton and Banka in the Dutch East Indies. We note with interest therefore a short article in the *Mine and Quarry* for August describing the shaft-sinking and development operations at the Tikoes mine in the district of Sidjoek, Billiton. The article is written by C. W. A. Lely, mining engineer to the Billiton Company. It is often supposed by the layman that Banka and Billiton tin is all alluvial. This is not so, however, for of recent years, with a diminishing output from the gravels, attention has been given to the lodes. The Tikoes mine was originally worked by Chinese tributers, who went to a depth of 90 ft. by open-cut, picking out the richest parts. Wolfram accompanies the cassiterite, and was first separated by hand-sorting, and afterward by a magnetic plant. The Billiton Company eventually took over the property and proceeded to develop at depth. A shaft was sunk in the granite country at a distance of 300 ft from the open-cut, and it has reached a depth of 350 ft. Three levels have been opened, and about 6,000 ft. of development done. The ore-body has been proved to be of considerable extent. The tin and wolfram are found disseminated finely through greisen, and also in quartz lenses within the greisen. In the quartz the crystals of cassiterite and wolfram are much larger. The greisen ore averages $2\frac{1}{2}$% metallic tin and 1% WO_3. The two classes of ore are treated in separate mills, the aggregate capacity of which is 200 tons per 24 hours. The shaft-sinking, development, and mining are done by Sullivan drills, various types of which are used for their special purposes.

Gravel Pumping at Heawood.—In a contribution to the discussion on J. J. Garrard's paper on "Mining the Swaziland Alluvial Tin Deposits," T. R. A. Windeatt gives, in the September *Bulletin* of the Institution of Mining and Metallurgy, some records of the gravel-pump practice at the Heawood tin mine, in the state of Perak, Federated Malay States. Mr. Garrard's paper was read at the February meeting of the Institution, and we gave long quotations from it in our March issue.

At the Heawood mine, the ground is broken down by two 2 in. monitors, and the gravel is raised by an 8 in. pump, which is driven through a long belt from a Pelton water wheel. The gravel is discharged into a 2-compartment sluice-box. The Pelton wheel is above the sluice-box, and the water leaving it is used in cleaning up, and also to assist in sluicing when both compartments are in service at the same time.

The following are the details connected with the Pelton wheel: Size of wheel 24 in.; nozzle, controlled by needle valve, maximum size $1\frac{1}{8}$ in. Gauge pressure, 220 lb. per sq. in.; nozzle 6 ft. 6 in. above gauge; effective head 508 ft. *minus* 6 ft. 6 in., equals 501·5 ft., or say 500 ft. Quantity of water employed 93·4 cu. ft. per minute. Theoretical horse-power, obtained by multiplying the weight in pounds of 93·4 cu. ft. per minute by the effective head in feet and dividing by 33,000, equals

$$\frac{93{\cdot}4 \times 62{\cdot}5 \times 500}{33{,}000} = 88{\cdot}44$$

The details of the monitors are as follows: Number, 2; diameter of nozzle 2 in.; pressure of water 65 lb. per sq. in.; effective head, 150 ft.; discharge, $2 \times 120{\cdot}9 = 241{\cdot}8$ cu. ft. per minute; seepage 20 cu. ft. per minute; total water raised from sump by gravel pump, 261·8 cu. yd. per minute; ground cut, estimated by monthly survey, 18,000 cu. yd. The ground is a soft clay soil containing 50% sand; 9·67 cu. ft. of water per minute is required to break 1 cu. yd. of ground per hour.

The following are the details of the gravel pump; Size 8 in.; speed, 482 r.p.m.; height lifted, 45·7 ft; ground raised per month 18,000 cu. yd., per hour 25 cu. yd.; ground raised per minute, 11·25 cu. ft.; taking the weight of 1 cu. ft. of ground at 100 lb, the ground raised per minute, 1,125 lb.; total water raised per minute, 261·8 cu. ft., or 16,310 lb.; theoretical horse-power 88·44; brake horse-power (at 75% efficiency) 66·33; work done per minute in raising 16,310 lb. water and 1,125 lb. solids through 45·7 ft. = 45·7 (16,310 × 1,125) = 796,785 ft. lb.; actual horse-power as per work done, 26; efficiency of installation, 26 ÷ 88·44 = 27·3%.

Zinc Metallurgy.—In the *Engineering and Mining Journal* for September 15, W. R. Ingalls writes on "zinc burning" as a metallurgical process. This article is an amplification of a paper presented to the American Institute of Mining Engineers, and mentioned in our last issue. The idea is to apply the Wetherill process for producing zinc oxide to the treatment of complex or low-grade ores by driving off the zinc as oxide. Many applications of the idea have been made in days gone by, notably by Ellershausen, Bartlett, and Pape. Recently the Anaconda company has applied the principle by erecting a reverberatory furnace for recovering zinc left in the residues at the electrolytic plant.

Handling Material by Skip Hoists.—*Engineering* for October 26 reprints a paper read before the Cleveland (U.S.A.) Engineering Society describing the application of the skip hoist to the moving of mining and metallurgical materials of surface works.

Shipment of Coal.—In the *Colliery Guardian* for October 19, F. J. Warden Stevens writes on methods of stacking and re-handling coal.

Indicators for Mine Hoists.—The *Iron & Coal Trades Review* for October 19 describes the Jobling visual and mechanical signal for use in connection with winding engines.

Mining at Miami.—In the *Mining and Scientific Press* for September 22, T. A. Rickard continues his article on the Miami copper mine, Arizona, describing the methods of mining.

Tungsten.—*Engineering* for October 26 describes the works of the High-Speed Steel Alloys Limited at Widnes, with an outline of the process for producing tungsten metal from wolfram and scheelite.

Vanadium Steel.—The role of vanadium in alloy steels is the subject of a paper by G. L. Norris, presented at a meeting of the American Society for Testing Materials, and quoted in the *Engineering and Mining Journal* for September 29.

Metallurgy of Antimony.—Papers by K. C. Li and D. J. Demorest were read at the September meeting of the American Institute of Metals on the metallurgy of antimony.

Cyanide from the Air.—In the *Mining and Scientific Press* for October 13, G. H. Clevenger describes experiments made with the object of obtaining sodium cyanide by the reaction of carbon, a sodium salt, and nitrogen contained in producer gas. We intend to quote the application of this method in our next issue.

Flotation.—In the *Mining and Scientific Press* for October 13, O. C. Ralston and L. D. Yundt discuss the effects of various chemicals when added to flotation pulp.

Power Costs.—At the October meeting of the Institution of Mechanical Engineers, Oswald Wans read a paper comparing the costs of various systems of generating power.

Petrol.—At the October meeting of the Institution of Petroleum Technologists, E. Lawson Lomax read a paper on the testing and standardization of motor fuel.

Pyrometry.—At the meeting of the Faraday Society held on November 7, a number of papers were presented and discussed relating to pyrometry.

European Coal.—At the September meeting of the Midland Institute of Mining, Civil, & Mechanical Engineers, George Blake Walker read a paper on the areas of deposition of the coalfields of Western Europe.

Refractory Properties of Silica.—A paper on this subject by H. Le. Chatelier and B. Bogitch was read at the October meeting of the Ceramic Society.

Flin Flon, Manitoba.—In the *Mining and Scientific Press* for October 13, Walter Karri-Davies describes a journey to the new copper district at Flin Flon, Manitoba.

RECENT PATENTS PUBLISHED.

3,904 of 1917 (109,401). CARL LANGER, Swansea. The co-inventor with Ludwig Mond of the Mond nickel process describes in this patent a new method of separating nickel from copper. The following is the specification:

It is well known that nickel oxides have less affinity for sulphur than have copper oxides. This fact has been utilized by treating finely ground well roasted nickel-copper matte with dilute sulphuric acid at a temperature of about 80° C. so as to dissolve out the copper oxide as copper sulphate. It is also well known that the addition of metallic nickel will precipitate copper from its sulphate solutions. The present invention is based on these known reactions and is carried out in the following manner. Bessemerized copper-nickel matte is, after being reduced to a fine powder, submitted to an oxidizing roast to convert the nickel and copper into oxides. These oxides are treated with an acid, preferably sulphuric acid of about 10% strength, at a temperature of about 80° C. which will dissolve from 60 to 80% of the copper-oxide converting the same into sulphate. The solution is separated from the residue by filtration. The residue is dried and reduced by means of water-gas, producer-gas, or other convenient reducing agent, to metal. This finely divided metal powder contains about 60 to 65% nickel, which is used for the precipitation of the copper from its above mentioned solution. The precipitation of the copper is carried out in vessels provided with agitators to keep the metal powder in suspension during the reaction. By using a slight excess of the metal powder over the theoretical amount required, all the copper present in the solution can be precipitated and a solution of nickel sulphate free from copper is obtained. From this solution the nickel can be recovered by any of the known methods, preferably by electrolysis with insoluble anodes, or the nickel sulphate can be recovered as such by crystallization. The precipitated copper can either be cast into anodes and then refined by electrolysis, or, if the object is the manufacture of copper sulphate, the precipitate can be reconverted into oxide by calcining and the copper redissolved in dilute sulphuric acid to form copper sulphate which is recovered from the solution by crystallization.

3,905 of 1917 (109,402). CARL LANGER and OTTO LANGER, Clydach, Swansea. This patent describes a variant of that covered by 3,904 of 1917; a strong hot solution of acid is used, the whole of the nickel and copper dissolved as sulphate, and the copper precipitated by the addition of finely divided nickel.

12,581 of 1916 (109,105). W. A. SCHMIDT, Los Angeles, U.S.A. Method of extracting soluble potash salts from felspar.

14,116 of 1916 (109,328). W. A. LOKE, The Hague, Holland. Smelting pyrite with titaniferous iron ore in an electric furnace, thus producing an iron free from sulphur.

1,225 of 1917 (109,381). U. WEDGE, Ardmore, Pennsylvania. Improved form of roasting furnace.

3,516 of 1917 (109,742). NEW JERSEY ZINC CO., New York, Filter bags for catching metallic fume.

9,228 of 1916 (109,817). H. L. SULMAN and H. F. K. PICARD, London. Improvements in the process for dissolving lead sulphate from complex material by means of hot brine solutions.

14,629 of 1916 (109,857). A. F. HALLIMOND, and W. G. FLETCHER, London. A magnetic separator for minerals.

7,396 of 1917 (109,952). P. H. LEDEBOER, London. Improvements in the method of smelting iron ores by means of reducing gases, and producing steel or wrought iron direct.

NEW BOOKS

Flotation. By T. A. Rickard and O. C. Ralston. Cloth, octavo, 420 pages, illustrated. Price 12s. 6d. net. San Francisco : *Mining and Scientific Press*.

In our issue of May, 1916, we reviewed the book entitled " The Flotation Process," issued by Mr. T. A. Rickard, and containing reprints of the many articles on flotation that had appeared in the *Mining and Scientific Press* after he resumed active control of that paper early in 1915. Since that volume appeared Mr. Rickard has published a great many other articles on the subject, and appropriately he now issues these and other papers in a new book called " Flotation." The volume contains, in addition, a number of articles specially prepared by Mr. Ralston. Of the articles, particular note may be made of Mr. E. E. Free's chapter on colloids, and Mr. R. S. Lewis's description of the treatment of flotation concentrates. Mr. Ralston contributes many chapters, dealing respectively with selective flotation, flotation oils, the mechanical developments in connection with flotation, the control of ore-slime, and the flotation of oxidized ores. Mr. Rickard himself contributes several reviews, notably one on the early history of the process. The book is essentially a report of progress. Current publication of investigations and views is helpful in the evolution of a new process. There are many investigators of flotation throughout the world who eagerly absorb all the available information and who will therefore thank Mr. Rickard for issuing this book.

Progress of the Geological Survey of Great Britain.

This pamphlet contains a summary of progress of the Geological Survey of Great Britain for 1916 and it is published at 1s. 6d. In England and Wales the principal work was an examination of the raw materials used in the manufacture of silica-bricks and other refractory products. In Scotland a similar investigation into refractory materials was made, as well as an examination of the ironstone deposits of Dalry and Kilbirnie in Ayrshire. There are also appendixes dealing with deep borings for coal at Pollington, Yorkshire ; for coal and ironstone at Bere Farm, Elham, and Folkestone, Kent ; a deep boring at Battle, Sussex, and the underground range of the Jurassic and Lower Cretaceous rocks in East Kent.

Journal of the Society of Glass Technology. We welcome the appearance of a new technical paper of high standard of excellence. The Society of Glass Technology was founded in November, 1916, for the purpose of assisting in the expansion of the British glass industry, an industry that we had allowed to drift into the hands of the Germans. One function of the society is to publish a quarterly journal. The first number contains reports of the first five meetings. Among the papers printed are the following ; British Glass Sands, their Location and Characteristics, by Dr. P. G. H. Boswell : British Glass-Making Sands, by C. J. Peddle ; the Annealing of Glass, by F. Twyman ; the Hermansen Furnace, by T. Teisen ; the Influence of Small Quantities of Chlorides and Sulphate in Producing Opalescence, by J. D. Cauwood and W. E. S. Turner. The section of the journal devoted to abstracts and reviews is unusually complete and well done, and readers will be kept fully informed of the literature on glass subjects published throughout the world. The secretary of the society is Dr. W. E. S. Turner, of the University, Sheffield.

COMPANY REPORTS

New Modderfontein.—This company belongs to the Central Mining group, and was formed in 1888 to acquire property in the Far East Rand. Milling started with 10 stamps in 1892, and the scale of operations has been gradually extended. In order to develop the southern part of the area, a circular vertical shaft was sunk. The first results of development in this deep section were not altogether satisfactory, and opinions as to the value of the ore disclosed showed some variation. The report for the year to June 30 records that development of the deep section was suspended at the end of 1916, sufficient ore having been disclosed to meet requirements when the shaft equipment is completed. The upper levels, notably the 9th and 10th, have continued to yield rich ore. During the year, 1,419,300 tons averaging 9·7 dwt. was developed throughout the mine, and on June 30 the reserve was calculated at 8,914,400 tons averaging 8·5 dwt., as compared with 8,013,370 tons averaging 8·4 dwt. the year before. The ore raised was 762,067 tons, and after the rejection of waste, 656,700 tons averaging 10·7 dwt. was sent at the stamps. The yield of gold by amalgamation was 231,097 oz. and by cyanide 110,998 oz., a total of 342,095 oz., worth £1,423,500, being 10·4 dwt., or 43s. 4d. per ton milled. The expenses charged to working cost were £638,482, or 19s. 5d. per ton, leaving a working profit of £785,017, or 23s. 11d. per ton. In addition, £55,705 spent on development was charged to capital account, and £264,966 was spent on surface plant required for treating ore to be raised from the circular shaft, these items being paid out of revenue. The shareholders received £455,000, being at the rate of 32½%. The metallurgical plant at the circular shaft should be completed by the end of 1917, but operations will be delayed until the winding plant has arrived.

Nourse Mines.—This company was formed in 1894 as the Nourse Deep to acquire properties on the dip of the Henry Nourse mine in the central part of the Rand. In 1905 the outcrop mine was absorbed, as was also the South Nourse in 1909. The control is with the Rand Mines group. Mining is rendered difficult by the unusual number of dykes and faults. A year ago the ore going to the West mill became unprofitable, so operations have been suspended in that section and attention centred on the Deep section, the capacity of the mill serving that section being increased to 600,000 tons per year. The report for the year ended June 30 shows that 566,708 tons was raised, and after the rejection of waste, 495,100 tons averaging 6·85 dwt. was sent to the mill. The yield of gold by amalgamation was 119,335 oz. and by cyanide 47,691 oz., a total of 167,026 oz., worth £695,026, being 6·75 dwt. or 28s. 1d.

per ton milled. The tonnage milled was less than capacity, but given a full supply of labour there is no reason why a full output should not be maintained in future. The working cost was £576,153, or 23s. 3d. per ton, leaving a working profit of £118,872, or 4s 10d. per ton. The working cost was 3s. 4d. greater than the year before, chiefly due to the smaller scale of operations. The shareholders received £103,477, being at the rate of 12½%. The development, especially that of the Main Reef Leader, has been satisfactory, and the ore disclosed throughout the mine during the year was 604,000 tons averaging 6·9 dwt. It has been necessary to reduce the estimate of the reserve in the Main Reef by 261,500 tons by the rejection of ore that will not now pay for mining. The estimate stands at 407,300 tons in the Main Reef, averaging 5·6 dwt.; 817,000 tons in the Leader, averaging 6·8 dwt.; and 936,100 tons in the South Reef, averaging 6·4 dwt. The prospects at the mine are better than for some time past.

Consolidated Main Reef.—This company was formed in 1896 to acquire gold-mining properties in the middle west Rand, owned by the Main Reef and Consolidated Angle-Tharsis, two companies that were formed in 1888 and 1893 respectively. The control was with the Neumann group, but has recently, since the death of Sir S. Neumann, been transferred to the Central Mining & Investment Corporation. Milling started in 1888, but was subsequently suspended on several occasions. The first dividend was paid in 1907, and the rate has slowly increased. The report for the year ended June 30 shows that 384,498 tons of ore was raised, and after the rejection of 11% waste, 341,025 tons, averaging 7·5 dwt. per ton, was sent to the mill. The yield of gold by amalgamation was 87,308 oz. and by cyanide 33,760 oz., making a total of 121,068 oz., worth £503,785, being 29s. 6d. per ton milled. The working cost was £332,848, or 19s. 6d. per ton, leaving a working profit of £170,937, or 10s. per ton. Out of the balance, £31,739 was spent on capital account for shaft-sinking, plant, etc., £30,066 was paid as taxes, and £92,436 was distributed as dividend, being at the rate of 10%. During the year, development eastward of the vertical shaft was suspended owing to the poor quality of the ore, but to the westward the results were satisfactory and considerable amounts of ore of good average grade were added to the reserve. The reserve on June 30 was estimated at 1,002,740 tons averaging 7·66 dwt., as compared with 856,740 tons averaging 7·51 dwt. the year before. The scarcity of native labour made it necessary to increase the proportion of ore won by machine drills. Details of the plan for absorbing the Main Reef West property are given in the Review of Mining elsewhere in this issue.

Main Reef West.—This company was formed in 1899 to acquire deep-level property in the middle west Rand on the dip of the Aurora and New Unified and to the west of the southern portion of the Consolidated Main Reef. The Bantjes adjoins it on the west. The control and management is the same as that of the Consolidated Main Reef. Milling commenced in 1909, and for two or three years satisfactory profits were made. More recently the position has been adverse, and the plan is to amalgamate with the Consolidated Main Reef. The report for the year ended June 30 shows that 348,239 tons of ore was raised, and after the rejection of 11% waste, 308,344 tons averaging 5·56 dwt. was sent to the mill. The yield by amalgamation was 58,999 oz. and by cyanide 21,699 oz., making a total of 80,698 oz., worth £335,704, equal to 21s. 9d. per ton milled. The working cost was £309,325, or 20s. 1d. per ton, leaving a working profit of £26,379, or 1s. 8d. per ton. Out of this profit, £26,309 was spent on capital account, chiefly in shaft-sinking. Development does not keep pace with extraction. The ore disclosed in the lower levels of the western section is of a disappointing character, and in the eastern section patchy. The reserve on June 30 was estimated at 487,030 tons averaging 5·92 dwt. per ton. Details of the proposed amalgamation with Consolidated Main Reef are given in the Review of Mining elsewhere in this issue.

Willoughby's Consolidated.—This company was formed in 1894 to consolidate various land and mining interests controlled by Sir John Willoughby and others. The control is now vested in the British South Africa Company. The only dividend paid was one of 5% in 1910. The capital issued is £700,314, and there are £185,700 debentures, also £45,000 debentures issued to bankers as security for a loan. The company operates the Eiffel Blue gold mine, which is near the Cam & Motor, and lets eight others on lease to tributers. The report for the year 1916 shows that at the Eiffel Blue 17,609 tons of ore was treated for a yield of gold worth £33,051, and that the working cost was £24,621. The company also received £2,626 as royalties from tributers. The farm and land receipts brought the total revenue to £79,681, and the net profit, after payment of debenture interest, was £21,472, which, added to the balance brought forward, made a total of £60,497. This has been written off to allow for depreciation of investments and mining property.

Abbontiakoon Mines.—This company was formed in 1901 as the Abbontiakoon (Wassaw) Mines to acquire gold-mining property in the Taquah district, West Africa. Part of the property was sold in 1903 to a subsidiary called the Abbontiakoon Block 1, but was re-absorbed in 1909, when the name of the company was changed. Milling was entirely suspended from 1909 to 1912, while development was pushed and a new treatment plant provided. To provide funds for the new plant, a loan of £140,000 was obtained from the Fanti Consolidated. Dividends were paid for 1914 and 1915. The report for 1916 shows that 128,029 tons of ore was raised, and after the rejection of waste, 117,885 tons, averaging 9·16 dwt., was sent to the mill. The yield of gold was worth £230,755, or 39s. 1d. per ton. The working cost, included depreciation, was £204,018, or 34s. 7d. per ton, and in addition £1,026 was paid as interest on loans, and £7,780 as income tax. The balance of profit for the year was £17,930. No dividend is paid, owing to the necessity of applying funds to increasing the supplies at the mine. During the year the loan of £140,000 was finally extinguished, but there is another temporary loan of £6,000 outstanding. The main shaft was sunk 128 ft. during the year, and is now 3,124 ft. deep. Development at the lower levels has not disclosed ore of equal grade to that above. The cost of operations has necessarily increased, and in consequence the ore reserve has been revised by omitting blocks averaging under 7 dwt. The figures on December 31, 1916, were 379,550 tons, averaging 9·7 dwt.; 165,765 tons, between 6 and 7 dwt.; and 395,587 tons below 6 dwt. For the first nine months of 1917, the ore treated has been 88,145 tons, the yield £159,248, or 36s. 1d. per ton, and the working cost, excluding depreciation, £141,221 or 32s. 0d. per ton. Edmund Davis is chairman, and S. H. Ford is manager.

Prestea Block A.—This company was formed in 1903 to acquire gold-mining properties in West Africa from the Prestea and Appantoo companies. Additional property was subsequently acquired from the

Appantoo company, and in 1911 the property of the Prestea company was absorbed. Milling commenced in 1906, but was suspended from 1909 to 1911 pending further development. The capital has been rearranged and increased on several occasions, and loans have also been raised. The Central Mining & Investment Corporation took shares and advanced money, and the corporation's engineer, H. F. Marriott, is consulting engineer to the company. The present share capital is £1,049,876. In May, 1916, the loans were repaid. The report for the year 1916, just issued, shows that 271,770 tons of ore was treated, for a yield of gold worth £401,680, or 29s. 6d. per ton. The figures for 1915 were 280,137 tons, £417,339, and 29s. 9d., respectively. The accounts show a loss of £35,971, which reduces the reserve account to £45,579. The adverse balance on the year's working is largely due to the increased amount charged to development. The ore reserve on December 31 was estimated at 528,888 tons averaging 38s. 6d. per ton, as compared with 634,264 tons averaging 38s. 3d. at the end of 1915. Owing to an underground fire and other adverse circumstances, the monthly output has been reduced to 20,000 tons. The treatment of tailing by the sodium sulphide process accounted during the year for gold worth £23,138. This process was developed by W. R. Feldtmann at Ashanti mine, and he read a paper on the subject before the Institution of Mining and Metallurgy in April, 1915. We understand that Mr Marriott is preparing a paper on the results obtained at Prestea.

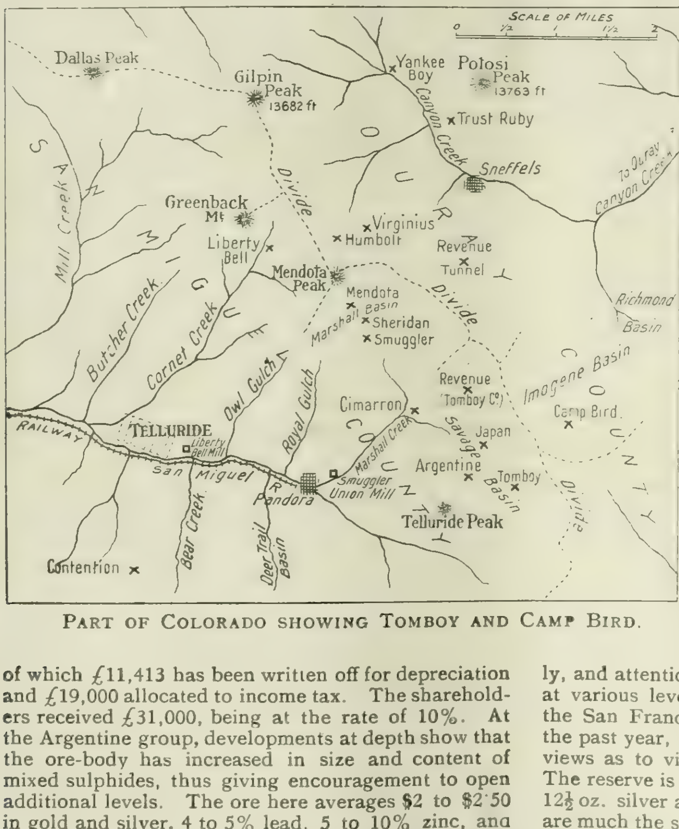
Niger Company.—This company was formed in 1882 as the National African Co., and from 1886 to 1900 held a Royal Charter empowering it to govern the territories in the basin of the River Niger, West Africa. In the latter year the British Government took over the administration, and the company continued the general mercantile business. Tin mining is one of the company's many interests. Most of the tin land is worked by other companies which pay royalty, but certain properties are operated by the company under the management of Laws, Rumbold & Co. The report for the year 1916 shows that the profits on general business account was £162,926, and on tin mining £45,538. Out of the total profit £37,493 was written off for depreciation, and £66,752 was placed to reserve. The debenture holders received £8,750 interest, the preference shareholders £30,000, and the ordinary shareholders £67,498 or 10%. As recorded in our August issue the company has recently, in association with the Rayfield Co., acquired alluvial tin ground previously held by W. Mertens & Co., of Hamburg.

Kamunting Tin Dredging.—This company was formed in London in 1913, as a subsidiary of F.M.S. Timah, Ltd., to acquire alluvial tin property at Kamunting, near Taiping, in the Larut district of Perak, Federated Malay States. It belongs to the same group as the Chenderiang and Kampong Kamunting companies. A bucket-dredge, built by Fraser & Chalmers, started work in March, 1913. The report for the year ended June 30, shows that 936,500 cubic yards of ground was treated, for a yield of 369 tons of tin concentrate, being an average of 0·88 lb. per cu. yd. The produce sold for £38,201. The cost at the property was £14,486, London expenses £1,563, allowance for amortization of capital £6,781, and net profit £15,926. The company was badly hit by excess profits tax during the year ended June 30, 1916, no less than £14,875 having been paid in this way, in addition to £4,392 as income tax. Fortunately the company is not liable for excess profits tax on the profits during the year just ended and it has been possible to declare an interim dividend of 5% for the current year. During the year under review, the cost per yard, excluding taxation, was 5·85 pence, and the yield per yard 9·79 pence.

Oriental Consolidated.—This company was formed in America in 1897 to acquire a gold-mining concession in north-western Korea. H. C. Perkins is president, and Alf Welhaven is manager. English shareholders are represented by the Central Mining & Investment Corporation. Dividends have been paid continuously since 1903. The chief mines are the Tabowie, Taracol, Chintui, Tongkol, and Charabowie. The first two have mills of their own, and the ore from the others is treated at the Maibong mill. The report for the year ended June 30 shows that at the Tabowie mine 132,441 tons of ore was treated for a yield by amalgamation of bullion worth $353,163 and by cyaniding concentrate $338,462, a total of $691,625, or $5·22 per ton. At the Taracol 103,097 tons yielded $219,691 by amalgamation and $189,840 by cyaniding concentrate, a total of $409,532, or $3·97 per ton. The output of the other mines brought the total yield to $1,585,200, from 317,601 tons of ore. The tailing from the concentrating tables is of so low a grade that it would not pay for treatment. The profit for the year was $694,015, or $2·19 per ton, out of which $419,390 was paid as dividend. The total ore treated since the beginning of operations was 4,462,598 tons, the yield $27,629,893, and the dividends $7,723,950. With regard to development during the year, 122,441 tons was disclosed at the Tabowie, averaging $5·63 per ton, and the reserve was estimated on June 30 at 550,000 tons averaging $6·00 per ton. A large proportion of this was found in the levels already developed. In the bottom levels the lode is narrow and irregular. At the Taracol 113,097 tons averaging $4·75 was disclosed during the year mostly in a hanging-wall vein, and on June 30 the reserve was estimated at 220,000 tons averaging $4·20. The total reserve at all the mines was 840,000 tons averaging 5·4 dwt. While the developments have been satisfactory, no extensions of the ore-bodies or new ore-shoots have been discovered.

Mount Morgan.—We gave a brief outline of the results of this Queensland gold-copper mine for the half-year ended May 27 in our September issue. The full report is now to hand by mail. During this period 144,453 tons of ore was raised, of which 81,762 tons was smelting ore and 62,691 tons went to the concentrators. The amount was 29,276 tons less than during the previous half-year, the drop being due to strikes and extra holidays. The ore raised during the twelve months ended May 27 averaged 2·61% copper and 6·86 dwt. gold per ton. At the concentration plant 62,213 tons of ore was treated during the half-year, averaging 2·02% copper and 5·67 dwt. gold. By jigs, tables, and flotation cells 19,503 tons of concentrates was produced, averaging 6% copper and 14 dwt. gold, the percentages of recovery being 93% of the copper and 77·8% of the gold. At the smelter 86,504 tons of ore, 16,544 tons of concentrates, and 19,179 tons of Many Peaks fluxing ore were treated, for a yield of blister copper containing 3,412 tons of copper and 44,088 oz. of gold. There was also treated on account of the Electrolytic Refining & Smelting Company 3,315 tons of ore yielding blister containing 547 tons of copper and 185 oz. of gold. The accounts show credits of £643,089 for blister copper, and a net profit of £167,689, out of which £150,000 was distributed as dividend, being 15% for the half-year. The ore reserve is estimated at 4,664,244 tons averaging 2·58% copper and 6·15 oz. of gold. Development consists nowadays of work undertaken to define the boundaries of profitable ore, and in two sections additions have been made to the reserve of concentrating ore.

Tomboy Gold Mines.—This company was floated in London in 1899 by the Exploration Company to purchase the Tomboy gold mine, at Telluride, Colorado. Shortly afterward, on the mine showing signs of exhaustion, the Argentine claims nearby were acquired. In 1911 the Montana group of claims on the opposite side of the basin were bought. The workings are in the sulphide zone, and concentrates of copper, lead, and zinc are obtained as well as gold-silver bullion by amalgamation and cyaniding. The report for the year ended June 30 shows that 148,939 tons of ore from the two groups was sent to the mill, where bullion worth \$314,822 was obtained by amalgamation and \$160,114 by cyanide, together with concentrates selling for \$675,674. The total yield was equal to \$7·73 per ton milled. Other small items brought the revenue to \$1,169,231. The working cost was \$811,966, or \$5·45 per ton. The accounts show a profit of £72,437, out



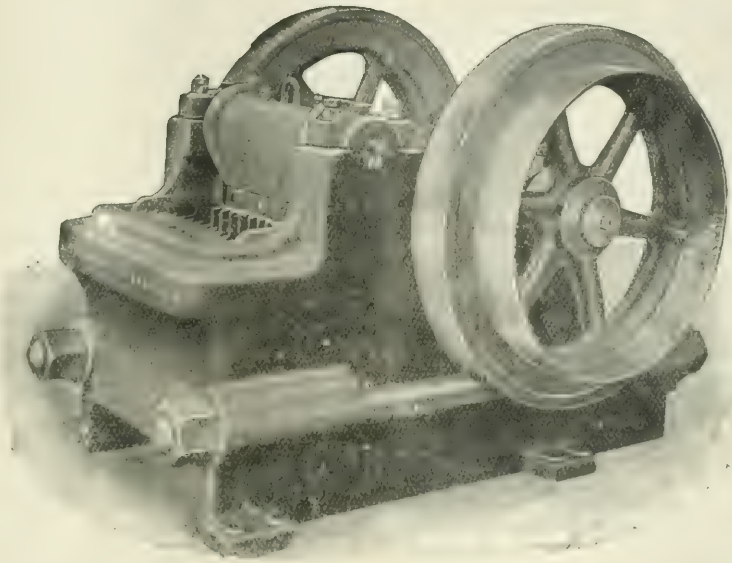
PART OF COLORADO SHOWING TOMBOY AND CAMP BIRD.

of which £11,413 has been written off for depreciation and £19,000 allocated to income tax. The shareholders received £31,000, being at the rate of 10%. At the Argentine group, developments at depth show that the ore-body has increased in size and content of mixed sulphides, thus giving encouragement to open additional levels. The ore here averages \$2 to \$2·50 in gold and silver, 4 to 5% lead, 5 to 10% zinc, and 1 to 2% copper. The reserve is estimated at 150,000 tons, of which 120,000 tons is ore broken in the stopes. This figure compares with 175,000 tons the year before. At the Montana group, the reserve has been well maintained at 390,000 tons. In addition, ore has been disclosed in the Sydney-White Cloud property recently acquired. Experiments are being made with selective flotation with a view to improving the extraction of sulphides. It is also hoped by this means to be able to treat ore not now included in the reserves.

Camp Bird.—As recorded a year ago the gold mine of this company, in Ouray county, Colorado, is exhausted as far as known ore reserves are concerned, and the mine and mill were closed in June, 1916. The report for the year ended June 30 last shows that work has been confined to a clean-up and to the dismantling of the mine plant. It is intended to sell the machinery when opportunity offers. Two years ago the directors instituted a plan for developing ground below the bottom of the mine by means of an adit, and formed a subsidiary to undertake the work. By the beginning of October this adit had been driven 7,278 ft. and the remaining 3,422 ft. required to meet the lode should be completed in June next. The company also has large interests in the Santa Gertrudis and Messina (Transvaal) companies. The accounts show a loss of £6,995 for the year. Deducting this from the forward balance, a credit balance of £78,275 remains. Out of this, £45,473 has been distributed as preference dividend, being at the rate of 7%, and £11,314 as income tax.

Santa Gertrudis.—This company is a subsidiary of the Camp Bird, which holds 75% of the shares, and was formed in 1909 to acquire a celebrated silver mine at Pachuca, Mexico. Operations were entirely suspended for a few months in 1914, and on several occasions have been crippled by the scarcity of cyanide. On the whole, the company has not suffered from the Mexican anarchy to so great an extent as some others. The report for the year ended June 30 shows that 213,872 tons of ore was treated, yielding bullion containing 1,989,761 oz. of silver and 11,154 oz. of gold. This amount of ore is not much more than half the capacity, the cyanide position being the cause of the low figure of output. The supply is now better assured and further scarcity is not anticipated. The report does not give details of the income and expenditure at the mine, and as nothing has been received in London from the local operating companies, the profit and loss account contains no mention of the financial results of mining. The receipts were £6,220 from interest and £2,638 from dividend on the company's holding in Messina (Transvaal) shares, and the net balance of profit was £1,798. As has been recorded on several occasions, the developments at depth have been poor recently, and attention has been given to lateral exploration at various levels. The advice of Wilbur H. Grant, the San Francisco geologist, has been taken during the past year, and his advice confirms the manager's views as to vigorous development at certain points. The reserve is estimated at 1,125,000 tons averaging 12½ oz. silver and 1¼ dwt. gold per ton; these figures are much the same as those of one and two years ago.

San Miguel Copper Mines.—This company was formed in 1904 to acquire a pyrite mine in the south of Spain. In 1907 the control passed to the same group as the Pena Mines. Small dividends were paid in 1912 and 1913. The report for the year 1916 shows that 21,192 tons was mined, of which 13,642 tons was sent to the leaching floors, and 6,911 tons prepared for export. In 1913 the output was 75,265 tons. During the year under review the production of fine copper in precipitate was 345 tons, and 34,243 tons of leached ore was despatched. The trading profit was £21,289, and after allowance of £11,995 for development, £5,142 for depreciation, and £2,152 as administration expenses, the profit for the year was £1,973.



LAKE VIEW & OROYA EXPLORATION, LIMITED.

Directors : F. A. Govett (*Chairman and Managing Director*), J. A. Agnew, J. H. Cordner-James, W. C. C. Romaine, W. F. Turner, Tyndale White. *Joint Secretaries :* Charles Lloyd, G. Goldthorp Hay. *Office :* 1 London Wall Buildings, London, E.C.. *Formed* 1911. *Capital issued :* £360,954. 10s. in shares of 10s. each.

Business : The financing of, and investment in, mines and mining companies.

The sixth ordinary general meeting was held on November 5 at River Plate House, London, E.C., Mr. Tyndale White presiding.

The Chairman expressed regret at the absence, through indisposition, of Mr. F. A. Govett, and proceeded to read a speech prepared by that gentleman, from which we give the following extracts :

The position of this company at the present moment is just simply and perfectly ridiculous, for in effect it is "out of action" owing to the operation of the excess profits tax, and indeed also of the income tax itself. The position is absolutely absurd and should be a matter for the profound consideration of any legislator possessed of a sense of humour or even of common sense ; it is, indeed, one of a series of lurid demonstrations that the whole question of the taxation of mines and mining exploration companies is in urgent need of reform. You will see from the report that we have made profits, or rather have received dividends and interest, amounting to a net amount of about £14,500. This sum is insufficient to pay a dividend—that is to say, any dividend that we should feel justified in paying, for I do not think we can attempt to resume the payment of dividends until we can see our way to continue paying them. We have confronting us the positive fact that we have no free working capital of any size, and in consequence of this we are not in a position to entertain new business of any magnitude, but we must keep in hand as capital all the available cash which we have at our disposal, in order to subsidize or bolster up the staggering enterprises, such as Leonesa and Granville, which form the raw material of the operations of such companies as this.

Our large holdings are the Burma Corporation, the Lake View and Star, and the Zinc Corporation, of which it is only the last which is paying any dividend. In addition to this, we are in receipt of smaller amounts by way of dividends or interest from smaller holdings, such as General Petroleum, Brixworth, etc. The Burma Corporation has not yet arrived at the stage of paying dividends, in consequence of the enormous size of the enterprise and the difficulties of erection of plant during the war ; and I do not look for any relief from this quarter for some time yet ; in fact, I cannot put with any certainty at all a date for the payment of its first dividend. For the period of the war, at any rate, the Lake View and Star has clean gone out, and the policy to which it is now condemned in order to keep alive, without actually losing money, makes the outlook for the subsequent future worse every month that it must be continued, for, as the company has no cash reserves, in order to save the expense of development it is using up the broken ore which has been paid for and treated as reserve. This was estimated to last for some nine to twelve months, and then we shall have to start and do more development work and pay for the cost of upkeep, with practically no working capital to do it, or shut down, which looks rather as though, if the war does not end within the next six months or so, the old Lake View Consols will be a thing of the past, leaving us to attempt to obtain a precarious existence from the Star, which at present is not being worked. The superintendent, Mr. Vail, does not seem to abate any of his former confidence in the mine itself, but I can never forget the extremely narrow margin on which we have worked for so many years ; and I wonder how far—if or when freight is once more available, so that we may obtain our mine stores at something like former prices, which in any case must be a matter of a considerable time—the increasing demands of labour will admit of any profit being made. However, for the moment let us ignore the outside factors, and accept Mr. Vail's more sanguine view that the mine is not yet dead.

We have, then, mainly to rely on the Zinc Corporation for our income in the immediate future, for there is no definite prospects of an end to this dreadful war, and after peace is declared how long will it take to get back to normal conditions? As soon, however, as Burma really gets to work and settles into its stride the position will be very different, for even a dividend of 10% would mean £10,000, while 25% would put this company back on its pristine basis of dividends of 10%, and the present price of Burma shares seems to postulate much higher dividends than that.

To return to the question of the taxation of mines, I have the revolutionary idea that, as a whole, certainly gold mining, and probably all base metal mining, does not pay, if you include in the calculation the whole expenditure from the start of prospecting to the death of the mine. Some mines never pay at all, and their whole record is entirely that of capital expenditure ; some reach the productive stage, but never achieve a profit divisible ; and the rest pay dividends for various periods and die—that is to say, some without having even returned any portion of the capital expended, very few the whole, while a tiny minority develop into established mines. The present custom is that the moment a mine arrives at the point of getting any revenue that revenue is treated as income and is liable to income tax ; this in this year of grace being no less than one-quarter of the whole, and this regardless of the fact that in the majority of cases this is just return of capital, and only a partial return at that. My claim is that, in view of the enormous risk involved in mining exploration, there should be no silly talk about income tax until the capital risked has been returned.

The Chairman concluded by moving the adoption of the report and accounts.

Mr. J. H. Cordner-James seconded the motion and it was carried unanimously.

NOTES BY J. A. AGNEW

On some of the principal interests of the Company.

Burma Corporation, Limited.—The holding of the Lake View and Oroya Exploration in the Burma Corporation remains the same as at the date of the last accounts, 100,000 shares. The ore reserves were estimated at December 31, 1916, to consist of 3,644,000 tons, containing 25·2 oz. silver, 27·4% lead, and 20·9% zinc per ton. The ore reserves as at June 30 last had increased to 3,793,000 tons. Since that date further developments on the Tiger Tunnel, or 653 ft. Level, have continued to show highly satisfactory results. It is anticipated that the north drive on the 4th Level will very shortly connect up with the old vertical shaft section, and the further vigorous development of the latter will be put in hand. Smelting operations have continued with but slight interruption, and this section of the plant is now dealing with 4,200 tons of ore from the mine per month. The average production of soft lead for the past nine months has been 1,442 tons, and the average monthly production of the fine silver for the same period has been 104,426 oz. The ordering of the first two units of the new crushing and concentrating plant has been completed, the actual shipment of this is in progress, and the work of preparing for its erection is being pushed with all possible speed. These two units should have a capacity of 750-800 tons minimum per day. The estimate of ore reserves published with this company's accounts as at December 31 last shows that the position is being more than maintained, an increase of 206,420 tons over that of the previous year being recorded, the assay value per ton remaining unaltered. Since that date the development work has continued to give very satisfactory results. The main north drive on the 9th Level (1,310 ft.) is out 334 ft. from the shaft, the last 224 ft. averaging 14·9% Pb., 2·5 oz. Ag. and 10·2% Zn. A west cross-cut off this drive at 200 ft. north has so far exposed 83 ft. width of ore having an average assay value of 12·2% Pb., 2·3 oz. Ag. and 9·1% Zn. The main south drive on this (ninth) Level is now out 472 ft. from the shaft, the last 125 ft. driven averaging 16·2% Pb., 2·6 oz. Ag. and 11·4% Zn. The main north and south drives on the 8th Level (1,180 ft.) have also continued to open up well, the former for the 642 ft. driven to date north of the shaft averaging 15·2% Pb., 2·9 oz. Ag. and 10·2% Zn., and the latter for the 510 ft. driven south of the shaft, 14·9% Pb., 2·3 oz. Ag. and 10·5% Zn. The main shaft was sunk to 1,591 ft. depth, and sinking was suspended pending the opening out of the 10th Level.

Sinking was resumed in Block 5 shaft during the year. This has now reached a depth of 1,210 ft. and plats have been cut east and west of the shaft for the 8th Level at 1,173 ft. depth. In cutting these plats and in the shaft at this horizon the zinc lode has been exposed for a width of 20 ft., averaging 8·8% Pb., 1·6 oz. Ag. and 19% Zn. It is, we understand, the intention of the company to vigorously develop this section and to make connection at once with the 8th Level in the main workings.

Lake View and Star, Limited.—The great shortage of labour which appears to be general throughout Australia, coupled with the marked inefficiency of much of that which is available, has continued to have a most prejudicial effect on this company's operations. In consequence of this and the gradual and steady rise in the price of all commodities, it became impossible to continue working without loss, and the directors of this company were recently faced with the necessity of either having to restrict milling operations to a limited tonnage of ore from the higher grade reserves or to shut down. They adopted the former of these two courses as the lesser evil.

Yuanmi Gold Mines, Limited.—The principal development work conducted on this property during the year was confined to the opening up of the ore-body on the 6th Level, winzing below that level, and sinking the main shaft. North of the main shaft, on the 6th Level, the ore-body has been proved continuous for a distance of 350 ft., the ore exposed being of average value. South of the main shaft the values on the whole, for a distance of 270 ft. driven, were very low. A winze at 200 ft. north was sunk 77 ft. in ore averaging 74s. over the 55 in. exposed. A winze at 35 ft. south was sunk a total distance of 117 ft. While values in this winze have been more erratic, the average exposed is about equal to that of the ore reserves. The latest advices indicate that the main shaft has been sunk to the 7th Level, and a commencement has been made to open out at that point. The ore reserves at June 30 were estimated to be 47,767 tons of an average value of 56s. 1d. per ton. This shows a slight decrease in tonnage, but a material gain in value. During the year 27,200 tons were treated, this consisting almost entirely of sulphide ore, for a recovery of £71,985.

Leonesa Mines, Limited.—As the outcome of considerable discussion between the boards of the Central American Mines, Limited, and the Lake View and Oroya Exploration, it was decided to liquidate the former, reconstructing it under the name of the Leonesa Mines, Limited. The £35,000 debentures held by the Lake View and Oroya Exploration in the Central American Mines, Limited, were converted into 199,979 shares of 4s. each fully paid in the Leonesa Mines, Limited, it being felt that the interests of share and debenture-holders would best be served by such an arrangement. As foreshadowed in our last year's report the treatment plant at Leonesa was closed down and the work of development only was proceeded with. Toward the end of February last the ore-body on the 3rd Level was cut at a distance of 247 ft. from the shaft, and the inrush of water was so great as to drown the pumps. Notwithstanding every effort made to cope with this work it had ultimately to be suspended pending the installation of increased pumping machinery. This has since been installed, and the ore-body cut through and driving has been commenced. The vein has been exposed for a width of 33 ft., the values being low.

Babilonia Gold Mines, Limited.—For the year ended December 31, 1916, the tonnage treated was 19,344 for a return of £40,526. The profit resulting from this yield, after allowing for working expenditure, mine development, and London office expenditure, £35,055, and £2,864 for depreciation of plant, &c., was £2,847. The ore reserves at December 31 last, calculated on a conservative basis, amounted to 39,124 tons, valued at £77,828. It is anticipated that on the opening up of the 3rd Level a substantial increase in these will be shown.

General Petroleum Company.—This company is now in an excellent financial position, and its wells are producing upwards of 5,000,000 barrels of oil per annum. It is also refining and transporting a large quantity of oil in addition to its own product. A very satisfactory arrangement has been made in the leasing of its Mexican oil lands. It has also taken an interest in promising oil-bearing country in Wyoming.

Granville Mining Company.—Owing to the failure of the Canadian Klondyke Company to pay the amount guaranteed by it to this company, it became necessary in the interest of both shareholders and bondholders to apply for the appointment of a receiver for both the Granville Company and also the North West Corporation, in which Granville is the largest holder. Negotiations are now proceeding with the object of financing the North West Corporation on a larger scale, which, if successful, may perhaps enable it next season to prove the effectiveness of the digging plant which hss been sent out, and failing the success of this to provide for the erection of a dredge.

THE NIGER COMPANY, LIMITED.

Directors: The Earl of Scarbrough (*Chairman*), C. B. Edgar (*Vice-Chairman*), Lord Aberdare, Lord Emmott, J. L. Goldie-Taubman, Sir H. H. Howorth, G. A. Moore, H. G. Shave, J. E. Trigge. *Secretary:* W. G. Rand. *Office:* Surrey House, London, W.C 2. *Formed* 1882. *Capital issued:* £674,983. 10s. in ordinary shares, and £500,000 in 6% cumulative preference shares, both of £1 each; debentures £175,000.

Business: Conducts a general mercantile business in Nigeria, including the operation of tin mines.

The 37th ordinary general meeting was held on October 18 at the Cannon Street Hotel, London, E.C., Mr. Clifford B. Edgar, vice-chairman of the company, presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that the figures laid before shareholders represented the results of a year's operations carried on under steadily increasing difficulties arising out of the war. They had seriously depleted staffs, both at home and in Africa, and greatly higher working costs, the charges for freight (especially those incurred this year on last year's produce), insurance, coal, and package having advanced in an unprecedented degree, and in the autumn of the year a new tax being imposed upon the trade in the form of export duties on certain kinds of produce. This measure appeared to have arisen out of the necessity for increased revenue in Nigeria, owing to the considerable financial burden which it was thought proper to lay upon the Colony and Protectorate as a consequence of the Cameroon campaign. The expenditure on buildings, stations, and steamers, which was extremely small in 1915, owing to the difficulties of obtaining material, now more nearly approached the normal, but they were inevitably behindhand with renewals to the fleet, and a larger sum than of late had been set aside for depreciation. The item of stock of goods and produce showed a large increase, and there were also increases in shipments afloat outward, and in cash and bills in Africa and in transit. The increase in investments was chiefly due to their having acquired a large interest in the business of R. Hassan and Co. Limited, which was more particularly a trade through Kano with the Arabs of the Central Sudan, and which had shown very satisfactory results in the past year. The profit and loss account showed a trading profit of £162,926, while the profits of tin working exceeded those of the previous year by over £17,000. After deducting directors' fees, debenture interest, and depreciation, the amount at disposal was £160,647, in addition to the sum brought forward. Out of this, the balance of preference dividend for 1916 and an interim dividend on the ordinary shares had been paid, £66,752 had been placed to reserve account, and from the balance it was proposed to pay a final dividend of 1s. 3d. per share on the ordinary shares, making 10% for the year.

The output from the tinfields continued to improve, and the general results and prospects more than justified the efforts made by the company in the earlier days—efforts which were still continued—to foster and develop the industry to the fullest extent. Judging from the returns for the first half of the current year, they might anticipate a further substantial increase in output. In 1916 the company acquired the rights in two mining areas, and during the current year they had, jointly with another company, purchased certain tin-mining leases previously in German hands. In view of the changed situation at Lagos, especially in connection with provisions and mining material supplies, it had been found desirable to resume operations at the port of Garua. Early in the present year the company opened its own agency in New York, and produce to the value of some £300,000 had already been sold through it, while it was proving of increasing value in procuring certain goods and supplies needed in Nigeria. The Liverpool office had been removed to the fine Cunard Building, where accommodation had been secured suitable for the company's standing and growing requirements.

They had recently acquired a controlling interest in the Company of African Merchants, Limited, by purchase of nearly the whole of the shares for cash. It was a company with which they had been working in agreement for a number of years, and part of its operations were in the sphere of the new main line railway to the coalfields, along the route of which their interests would necessarily develop. Mr. G. A. Moore, hitherto chairman of that company, who had had some 40 years' experience of West African business, had been appointed to a seat on their board, in succession to Mr. Alexander Miller.

Lord Aberdare seconded the resolution.

A short discussion followed, in the course of which Mr. J. B. Concanon said that, in view of the difficult conditions which had prevailed, he considered that the results of the working for 1916 had been extremely satisfactory. He had noticed some disappointment was expressed in certain newspapers as to the dividend, but, in his opinion, it would have been very weak-minded, to use no stronger expression, on the part of the directors, if they had made a larger distribution.

Mr. Joseph E. Trigge said that it was with very great pleasure that he had the opportunity of saying a word or two with regard to the staff. The shareholders would recognize that the board felt the absolute necessity of leaving the control of the company's business very largely—indeed, almost entirely—in the hands of the men on the spot, and it was very hard for the board, and still harder for the shareholders, to realize the difficulties these men had to face during the war period. He thought, with the chairman, that this was not a question for a formal vote. The men had devoted themselves untiringly to the work of the company, realizing that they were doing work of great importance for the Empire as well as for the company. The mining branch of their business was in the hands of Messrs. Laws, Rumbold, and Co., and Mr. Laws—now Major Laws, D.S.O.—and his staff in the early part of the war did wonderful work. Now many of their men were at the front, several of them had made the supreme sacrifice, others had taken their places, and were "carrying on." They had a large mining staff. Many of the men's services had extended over long periods, not only the mining men, but also many of the commercial men. Some of the more seasoned had not taken any leave since the outbreak of the war. The board had set aside a certain sum so that if any of them came home invalided they would be, at any rate, promptly provided for.

The resolution was carried unanimously.

THE UNITED EXPLORATION COMPANY, LIMITED.

Directors: Edmund Davis (*Chairman*), Alfred Blondel, Sir Robert A. Hampson, Cecil Quentin. *Secretary:* H. W. C. Dermer. *Office:* 19 St. Swithin's Lane, London, E C. *Formed* 1909. *Capital issued:* £105,927 in shares of 2s. each.

Business: Conducts an exploration, financial, and investment business; among other interests are those in Fanti Consolidated, Abbontiakoon, the Chrome Company, and Mount Oxide.

The ordinary general meeting was held on November 7 at the offices of the company, 19 St. Swithin's Lane, London, E.C., Mr. Edmund Davis (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said: Gentlemen,—We now present our accounts to September 30, 1917, the issued capital being the same as at September 30, 1916, and creditors, £150, show a reduction of £3,300, the only other item on this side of the balance sheet being a note referring to uncalled liability on shares and interests in other companies, £3,822, or a reduction of £117, comparing with the amount set out in the note at September 30, 1916. Turning to the other side of the accounts, shares and interests in other companies now stand at £81,792, comparing with £102,949 at September 30, 1916, or a reduction of £21,157; but, on the other hand, cash in the present accounts stands at £16,265, comparing with £230 in the previous accounts—that is, an increase of about £16,000. Debtors are about the same at £1,024, as compared with £957, the only other item on this side of the balance sheet being the balance of profit and loss account, £6,994, which shows a difference of £1,755 comparing with the previous accounts, this difference being due to the balance loss for the year under review. Our shares and interests in other companies stand in the balance-sheet at market quotations, or valuation where there was no quotation, but not over prices fixed for reduction of capital in 1915 or cost of shares acquired since. When comparing investments with those set out in the report issued on November 29, 1916, there is a reduction in the interest held in the Maikop Combine, Ltd., Six per Cent Debentures of £555, a small reduction of £58 in the Rayfield (Nigeria) Tin Fields, Ltd., Six per Cent Debentures, and the Leasehold Assurance, £9,575, no longer appears in the list, this amount having been received during the year under review.

Our principal interest is in the Fanti Consolidated Mines, Ltd., which interest has been further increased since the date of the accounts. We have always been of the opinion that if the capital of the said company were reduced so as to dispose of the large depreciation on some of its investments, regular dividends should be returned to its shareholders, and, as the general meeting of the Fanti Consolidated Mines, Ltd., will shortly be held, this matter will no doubt be dealt with then, and any proposal giving effect to this suggestion should have the unanimous support of the shareholders. At our last meeting, held on December 6, 1916, I stated that the Fanti Consolidated Mines, Ltd., position was very sound. It is even better now, and in addition its manganese deposits in the Gold Coast Colony are opening out in a very satisfactory manner. Since December 1 last, 20,122 tons have been shipped off its own property, in addition to 4,138 tons which have been shipped off an adjoining one in which it is largely interested. Our next important interest is our holding in the Abbontiakoon Mines, Ltd., and you will have gathered from the remarks at the meeting of shareholders of that company, held on October 30, that, although they have a balance of £52,984 profit, they are unable to make any distribution by way of dividend owing to the large amount of capital they have had to invest in stores and plant, the addition in stores alone, according to their last accounts, being £20,577 over that held for the previous twelve months. Our Auckland Park interest should appreciate in the course of time and be worth far more than the amount at which it stands in our books. The Baluchistan Chrome Company, to which reference was made at our last meeting, has now reached the producing stage, and since the date of the report additional arrangements have been made in reference to shipping, and, provided nothing unforeseen occurs, the company in question should make fair profits in 1918. Satisfactory arrangements have been made by the Chrome Company in reference to the shipment of ore, and large tonnages should be dealt with this month, December and January and April onwards, there being a break in February and March, owing to the general unfavourable state of the weather during that part of the year. We are still largely interested in the Mount Oxide Mines, Ltd., and you will have noticed by the publication in the press that the Mount Elliott, which owns Mount Oxide and other properties, has temporarily suspended smelting operations, but will restart at the beginning of next year, as by then the installation of labour-saving appliances and some necessary alterations to the plant will have been completed. We hold large interests in the Anfargah Gold Mines, Ltd., and the Effuenta (Wassaw) Mines, Ltd. The former company owns a gold-mining proposition adjoining Prestea Block A, but although development has proved the existence of reefs of fair value no work is being carried on at the moment, and some of the company's resources are being used in an oil proposition in Canada. The Effuenta adjoins the Taquah Mining and Exploration Company's property in the Gold Coast Colony. Development was stopped several years back, its management considering it advisable to suspend operations pending additional work being carried out on the adjoining property, as the result of such work should give a fair idea of the value of the Effuenta ground in its immediate neighbourhood. The Effuenta Company holds £15,000 War Loan and has about £3,000 cash and short loans.

Mr. Cecil Quentin seconded the motion.

The Chairman, in reply to questions, said that with regard to the National Railways of Mexico the directors had no information except what was published, very rarely, in the press. The San Francisco Mines of Mexico were not operating their property at the moment, owing to the unsettled state of the country. The Singapore Electric Tramways were doing well and the United Exploration Company were receiving dividends on their holdings. The Yangtse Valley Company, which originally had some property in China, was gradually realizing its assets. The shares were originally £1 shares, but two applications had been made to the Court and capital had been returned to shareholders to the extent of 14s. per share.

The motion was adopted unanimously.

CAMP BIRD, LIMITED.

Directors : F. W. Baker (*Chairman*), L. Clerc, F. A. Govett, F. H. Hamilton, O. de Rivaud. *Technical Committee :* J. A. Agnew. L. Chevrillon. *General Manager :* W. J. Cox. *Secretary :* A. A. Kelsey. *Office :* 1 London Wall Buildings, London, E.C. *Formed* 1900. *Capital issued :* £649,625 in preference shares and £1,100,051 in ordinary shares.

Business : Was formed to work the Camp Bird gold mine in Colorado ; holds the majority of the shares in Santa Gertrudis Co., and debentures in the Messina (Transvaal) Development Co.

The sixteenth ordinary general meeting was held on November 12 at Salisbury House, London, E.C., Mr. F. W. Baker, chairman of the company, presiding.

The chairman, in moving the adoption of the report and accounts for the year ended June 30, said that, after deducting £6,753. the debit to profit and loss on the year's operations from £85,028, the balance carried forward from last year, and deducting the two preference dividends Nos. 11 and 12 amounting to £45,473. 15s. 0d. and income tax £11,314. 10s. 0d., there remained a balance of £21,487. 19s. 6d. carried forward. The profit and loss accounts showed for the first time in the history of the company the absence of any figures representing profit earning from both the Camp Bird and Santa Gertrudis properties. The absence of earning from Camp Bird required no comment, the reason being well known. The absence of earning from the Santa Gertrudis would be dealt with in detail in the proceedings of the Santa Gertrudis Company. This position was not a satisfactory one, and varied considerably from the past record of approved years of successful dividend returns. He felt sure that any shareholders who were present at the annual meeting last year would find no grounds for anticipating any result at the Santa Gertrudis other than the one the cold facts of which were before them. He had then said regarding the outlook for the then current year that they had in hand at the date of the meeting returns for the first five months of the financial year and those returns indicated quite clearly the fact that they were not going to do nearly as well as they had for the year then under review, and he gave as the causes of this result the large increase in wages, taxation, shortage of cyanide, and a 60% increase in the cost of almost all supplies required on the property. He stated that under those circumstances it would be futile to attempt to outline in the barest degree what the balance of the financial year might bring forth. Owing to the causes then described, the Santa Gertrudis property had been operated at what he might call practically no profit for the twelve months ended June last, so that they had been compelled to meet their obligations in respect of preference dividends and income tax by a serious encroachment on the balance carried forward from last year.

With regard to the work that had been done at the Camp Bird mine, the new low-level tunnel was advanced for the year to a point 6,115 ft. from the portal. Though the ground had been uniformly hard and one or two serious delays took place owing to large flows of water having been encountered, the average daily rate had been very good and quite up to expectations. Several veins had been passed through, ranging in width from a few inches up to six feet. As the work of advancing the tunnel would have been seriously interfered with if any attempt had been made to open out on any of these veins, the latter work had been postponed pending the completion of the tunnel itself. In common with all other enterprises of this character, there had been felt an appreciable rise in the price of all commodities, this increasing the cost of the work. The labour supply, too, had been inadequate and the cost of that available had greatly increased. Every effort had been made to safeguard the interest of the Camp Bird Tunnel, Mining, and Transportation Company in respect of the location of any vacant ground traversed and in securing a title to the various veins passed through by the tunnel. It was anticipated that the Camp Bird vein would be intersected in June, 1918.

He was glad to be able to report that their substantial holding in the Messina (Transvaal) Development Co. Ltd. was now on a dividend-earning basis, and all the information that they had from the property was of a satisfactory character.

The death of their late colleague, Mr. de Pass, created a vacancy on the board, and the directors decided to approach Mr. A. Stanley Elmore, a gentleman of large metallurgical and mining experience to join the board. Mr. Elmore agreed to accept the position and was duly elected.

He regretted that he had not been in the happy position of being able to make a more cheerful statement as to the result of their operations for the past year. The reasons did not lie with the value of any of their assets or the large earnings that those assets could realize. He thought he had made it abundantly clear that had they been operating under normal conditions they could have been earning a sum equal to any of their earlier and best years. Conditions had affected them as they affected a lot of other industries. However, he felt now and for the first time for the last four or five years that the Mexican situation was settling down, and if the results of the earlier months of the present financial year formed any basis for judgment, then he certainly felt that when they met again he would have a much more cheerful statement to lay before them.

The Chairman then referred to a matter which had been referred to in the press, namely, the sale of 100,000 Santa Gertrudis shares by this company. He had always felt that the Santa Gertrudis shares were what he might describe as a one-man holding, the control being practically in this company with very little public interest in the security. This was a source of weakness, and as they were approached by a very influential group who sought to become interested and whose co-operation they felt would be of great value they entered into negotiations which finally resulted in the sale of 100,000 shares. It would be manifestly unfair to the buyers for him to disclose any of the particulars of the transaction, which he did not propose to do beyond saying that the board were satisfied with the price obtained. At the same time, should any shareholder feel that he was entitled to further information on this matter he would be very glad to furnish him privately with particulars.

Mr. A. Stanley Elmore seconded the resolution, which was carried unanimously.

SANTA GERTRUDIS COMPANY, LIMITED.

Directors: F. W. Baker (*Chairman*), L. Clerc, F. A, Govett, F. H. Hamilton, O. de Rivaud. *Technical Committee:* J. A. Agnew, L. Chevrillon. *Advisory Engineer:* W. J. Cox. *Secretary:* A. A, Kelsey. *Office:* 1 London Wall Buildings, London, E.C. *Formed* 1909. *Capital:* £1,500,000.
Business: Works the Santa Gertrudis silver mine, at Pachuca, Mexico.

The ninth ordinary general meeting was held on November 12 at Salisbury House, London, E.C., Mr. F. W. Baker, chairman of the company, presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, said that the balance of account after meeting all expenses and providing £2,000 to meet income tax liabilities was £1,798. They would remember that at last year's annual meeting he foreshadowed results which had approximated very closely the results achieved. He stated then that the first five months of the financial year indicated, unless conditions improved, that they were not going to do well, owing to the large increase in wages, taxation, shortage of cyanide, and a 60% increase in the cost of all supplies required for the property. He pointed out that it would be futile to attempt to outline what the balance of the financial year might bring forth. Owing to the causes enumerated, the Santa Gertrudis property had been operated at practically no profit for the twelve months ended June last. He felt they might now have reached the end of their years of depression, for he believed that the causes were disappearing, and he was influenced in expressing this view by the reports from their advisers that conditions in Mexico from a political and financial point of view were steadily improving. During the year under review they were successful in making arrangements with the Ministry of Munitions so that they were now assured of a constant and regular supply of cyanide, so that they did not anticipate that their profits would be affected as they had been in the year under review by a reduction in our milling operations to as low a record as a 53% capacity of the mill. This factor alone had materially affected the profit of last year's operations—a condition which he felt would not recur. The labour problem again had materially improved. They had all the labour they now required, with a more settled condition. and they did not look for the shut-downs and troubles which they had experienced in the past, and while there had been no reduction in wages and costs in mine and food supplies, the abnormal increase in the price of silver had about off-set these increases, so that they were now earning a monthly profit which was beginning to approximate their earnings before the political disturbance in Mexico arose. But he would wish to emphasize the fact that these profits would be dependent to a large extent on silver maintaining an average round about the present price. It was very difficult —indeed they had found it almost impossible—to get any reliable judgment as to the trend of the silver markets, for within the last six weeks they had had variations equal to almost 1s. per ounce. Opinions were expressed in reliable quarters that silver would remain around the present price for a long time. If this proved to be the case, he thought they might congratulate themselves, for the rise or fall of one penny per ounce on their monthly output based on running the mill at its normal capacity represented an increase or decrease of £1,500. for each penny as silver rose or fell.

During the period under review there were treated 213,872 dry tons of ore having a gross value of £395,374 or an average of £1. 16s. 11d. per ton, of which £1. 13s. 2d. was recovered. The bullion contained 11,154 ounces of gold and 1,989,761 ounces of silver. The average price governing silver sold during the year was 33·16 pence per standard ounce, as against a present selling price of 43⅜d. Their advisory engineer reported that the ore reserves at June 30, 1917, were estimated at 1,125,000 dry tons containing 68,783 ounces of gold and 13,756,756 ounces fine silver. The recoverable amount was estimated at 61,904 ounces of gold, and 12,381,080 ounces of silver. The ore reserves reported as at June 30, 1916, were estimated at 1,214,000 tons with a recoverable amount of 66,964 ounces of gold and 13,392,981 ounces silver, so that notwithstanding the extraction of 213,872 tons of ore during the year under review they had only depleted these reserves by about 90,000 tons. The present ore reserves, notwithstanding the large tonnage extracted in the last six years, stood about the same figure as they did at that time, showing that development work had developed during that period enough tonnage to keep the mill in operation on the basis of the tonnage handled without any reduction of the reserve.

He advised them at the last meeting that during the current year the development work being carried out on the lowest or 22nd level would determine one way or the other the value of this great body of ore at that point. The results obtained at this level and the geological evidence disclosed gave very little encouragement for the future of the mine in depth. A good deal of exploratory work had been carried out in the walls of the principal ore veins and occasionally small blocks of highly remunerative ore were to be met with in this work.

Some months ago their manager, Mr. Hugh Rose, arranged for examination of the mine workings by an eminent American geologist. Mr. Grant, the geologist in question, confirmed the manager's view regarding the 22nd level developments in depth and also was in agreement with their advisers regarding the possibility of discovering other and new makes of ore in the walls so far unexplored. In view of the encouraging results obtained at several points where this work had been carried out it was proposed to continue vigorously the developments of this ground.

He thought he had made it abundantly clear that had they been operating under normal conditions they could have been earning in the past year a sum equal to any of their earlier and best years. Conditions had affected them as they had affected a lot of other industries. However, he felt now and for the first time during the last four or five years that the Mexican situation was settling down, and if the first three months of the present financial year formed any basis for judgment, then he certainly felt that when they met again, he would have a much happier statement to lay before them, and should the result of these early months continue, he thought he could point to a certainty of resumption of dividends at a not distant date. What the dividend would be it would be difficult to say, because it was dependent on the price of silver; but he thought if they continued as they were now continuing they might get 10 per cent.

Mr. A. Stanley Elmore seconded the resolution and it was carried unanimously.

NORTH ANANTAPUR GOLD MINES, LIMITED.

Directors: John Taylor (*Chairman*), Capt. W. B. McTaggart (*Vice-Chairman*), C. C. Ellis, V. H. Smith, H. C. Taylor. *Managers and Consulting Engineers:* John Taylor & Sons. *Secretary:* W. L. Bayley. *Office:* 6 Queen Street Place, London, E.C.4. *Formed* 1908. *Capital issued:* 76,253 ordinary shares, and 25,000 preference shares, both of £1 each.

Business: Works a gold mine in the Anantapur district, Madras Presidency, India.

The tenth ordinary general meeting was held on October 18 at 6, Queen Street Place, London, E.C., Mr. John Taylor (chairman of the company), presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, said that during the year 26,500 tons of quartz was treated at the mill and 12,135 oz. of gold produced. There was submitted to the cyanide process 31,200 tons of tailing, 1,468 oz. of gold being obtained from this source. The total production was 13,603 oz. of fine gold of an estimated value of £57,705, an increase of £1,246 as compared with the previous year. This satisfactory result was mainly attributable to higher grade ore being crushed at the battery. The extraction at the mill was 9 dwt. 4 gr. of gold per ton, as against 7 dwt. 12 gr, for the preceding 12 months, the extraction at the cyanide plant being 22 gr. per ton in both cases. The quantity of ore passed through the battery was 5,890 tons less than in 1915–16, but 7,000 more tons was treated by the cyanide process. The expenditure on revenue account amounted to £35,366, and the net receipts to £58,718, the profit showing a substantial increase, being £23,352, as compared with £17,725 for the year before. The total amount standing to the credit of profit and loss account was £27,555, and the debit was £11,813, leaving a credit balance of £15,742. The total distribution of dividends for the year was at the rate of 4s. 6d. per share on the preference shares and 6d. per share on the ordinary shares, these dividends being of similar amounts to those paid for the previous year. In July last the company purchased a further half square mile of land, immediately to the north of the original property, having a length of half a mile on the course of the lodes. The purchase price was 15,000 fully-paid ordinary shares of £1 each in the company.

Mr. C. C. Ellis seconded the resolution.

Mr. Henry C. Taylor then described the development and exploratory work. The mine had been deepened 229 ft. to a total depth of 1,179 ft. and work had been started at a new 1,150 ft. level. The 950 ft. level (north of No. 5 shaft) was driven 175 ft. on the main reef, which continued poor and ill-defined. A cross-cut east at 850 ft. north of the shaft was then put out, and intersected the east reef. It had been driven on north and south from the cross-cut for a distance of 471 ft., and for a length of 416 ft. the reef averaged fully 4 ft. in width without a break, but it was generally of a mixed character. Several short lengths, however, aggregating 92 ft., gave an average reef width of 4 ft. 7 in., assaying 7¾ dwt. per ton. The last 69 ft. driven had been in the northern extension of ground recently acquired, and here, although the reef still maintained a fair width of 3 ft., its value over the last 50 ft. had been unpayable. It was obviously to the company's interest to acquire the extension of ground at the earliest opportunity, seeing that a strong reef formation was heading in that direction.

The resolution was carried unanimously.

GENERAL MINING & FINANCE CORPORATION, LTD.

Directors: Sir George Albu (*Chairman*), L. Albu, J. Freudenthal, M. Luebeck. *Managing Directors:* Sir George Albu, L. Albu. *Secretary:* H. W. Dalton. *Office:* Johannesburg. *London Office:* Winchester House. *Formed* 1895. *Capital:* £1,875,000.

Business: The finance and management of mines on the Rand.

The 17th ordinary general meeting was held on August 17, at Johannesburg, Sir George Albu presiding.

The Chairman, in moving the adoption of the report and accounts, said that they had fully maintained their position, notwithstanding the increasing difficulties experienced during the period in the shape of the enhanced prices of mining supplies, additional war bonus to the employees, and the diminution in the native labour supply. These disabilities were particularly apparent in the case of the mines which were of comparatively low grade. The returns for the latter half of 1916 showed a diminution in revenue as compared with the previous six months, and this aspect was largely responsible for the increase of £34,032 in the depreciation in the balance sheet. On the other hand, the net profit for 1916 was £20,509 in excess of the figure for 1915, and enabled them to convert the debit balance on profit and loss account brought forward from the previous period into a small credit balance of £5,093, which was carried forward to the current year. The financial position of the corporation at December 31 last showed a distinct improvement as compared with the position at the close of the previous year. During the year they had on balance increased their holdings in their own companies by £7,256, but had realized holdings in other companies to the extent of £15,964. They had also sold debentures, etc., of the book value of £42,372, and amounts were repaid to them in respect of advances against security to the extent of £14,929. Sundry debtors (including advances to mining and other companies) showed a big reduction of £368,535 as compared with the previous balance sheet; this was chiefly due to repayments by the Roodepoort United and Aurora West companies, the indebtedness of the Roodepoort United having been taken over by one of the banking institutions under the guarantee of the corporation. The debit balance on profit and loss account of £30,523, which appeared in the balance sheet for 1915, had been wiped out by the net profit for 1916. These changes in all amounted to a net realization of £464,315 of the assets of the corporation during the past year, which had been applied in the reduction of the liabilities to the extent of £458,294. On the other side of the balance-sheet, they had repaid deposits to the extent of £97,479, and sundry creditors showed a diminution of £356,312. These reductions made up the total decrease of £458,294 in the liabilities.

The motion was carried unanimously.

Professional Directory

AGNEW, John A., Tel.: 3700 London Wall.
Mining Engineer,
1 London Wall Buildings, London, E.C.

ALDRIDGE, Walter H.,
Mining and Metallurgical Engineer,
c/o Wm. B. Thompson, 14 Wall St., New York.

ARGALL, Philip, & Sons,
Mining and Metallurgical Engineers,
First National Bank Bdg., Denver, Colorado.
Cable: Argall. Code: Bedford McNeill.

ARNOLD, Ralph,
Consulting Geologist,
921 Union Oil Building, Los Angeles.
Cable: Arnoil. Code: Bedford McNeill.

BALL, Sydney H.,
Mining Geologist,
71 Broadway, New York City.
Cable: Sydball.

BANCROFT, Howland,
Consulting Mining Geologist,
Suite 730 Symes Building,
Denver, Colorado.
Cable: Howban. Code: Bedford McNeill.

BARBOT de MARNEY, E. N.,
Mining Engineer,
W.O. Sredney Prospect 33, Petrograd, Russia.
Cable: Barbot de Marney. Code: McNeill 1908.

BAYLDON, H. C.,
Mining Engineer,
"Karagandy," Akmolinsk, Siberia.

BEATTY, A. Chester,
25 Broad Street, New York.

BELLINGER, H. C.,
Metallurgical Engineer,
c/o Chile Exploration Co., Chiquicamata
(via Autofagasta), Chile, South America.

BOTSFORD, Robert S.,
Mining Engineer,
c/o F. Riches, Esq.,
Basil Island, 9 Line No. 44, Petrograd.

BRETT, H. T.,
Metallurgical Engineer,
Falcon Mine, Umvuma, Rhodesia.
Cable: Brett, Umvuma. Usual Codes.

BRODIE, Walter M.,
Mining Engineer and Metallurgist,
50 Broad Street, New York.

BROWN, Gilmour E.,
Mining Engineer and Geologist,
c/o George McBain, No. 1, The Bund,
Shanghai, China.

BROWN, R. Gilman, Tel.: Avenue 4018
Mining Engineer,
7 Gracechurch Street, London, E.C.
Cable: Argeby. Usual Codes.

BRYANT, J. W.,
Mining Engineer,
6 Parkvedras, Truro, Cornwall.

BULKLEY, J. Norman,
Consulting Mechanical & Electrical Engineer,
Mining Work a specialty.
120 Broadway, New York, U.S.A.

BURCH, CAETANI & HERSHEY.
BURCH, Albert,
Consulting Engineer,
Crocker Building, San Francisco.
Cable: Burch. Usual Codes.

BURCH, H. Kenyon,
Mechanical & Metallurgical Engineer,
c/o The Sierra Madre Club,
Los Angeles, California.

BURCH, CAETANI & HERSHEY.
CAETANI, Gelasio,
Consulting Engineer,
Crocker Building, San Francisco.
Cable: Caetani. Usual Codes.

CAMPBELL, Donald F., Tel.: Victoria 2682.
17 Victoria Street, London, S.W.
Cable: Mixoist. Code: Bedford McNeill.

CARLYLE, E. J., Code: Bedford McNeill.
Metallurgical Engineer
To the Sissert Co., Ltd., Polefskoy Zavod,
Perm. Government, Russia.
Cables: Carlyle, Ekaterinburg.

The Mining Magazine

FOUNDED IN 1909 BY T. A. RICKARD AND EDGAR RICKARD.

W. F. WHITE, *Managing Director*. EDWARD WALKER, M.Sc., F.G.S., *Editor*.

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938*. Telegraphic Address: *Oligoclase*. Codes: *McNeill*, both Editions.

BRANCH OFFICE: 420, Market Street, San Francisco. SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XVII. LONDON, DECEMBER, 1917. No. 6.

CONTENTS.

EDITORIAL

PROFESSORS at the Royal School of Mines are to the front on the list of lecturers before the Royal Society of Arts. This month Professor H. C. H. Carpenter delivers three Cantor Lectures on developments in the metallurgy of copper, while Professor William Frecheville is to lecture on the mineral resources of the Empire early in the new year.

AMONG the many scientists who have experimented on the artificial production of diamonds must be included Sir Charles A. Parsons, of steam-turbine renown. The subject has engaged his attention for thirty years, and his researches have led to other useful results in connection with physical chemistry besides those to which they were specially directed. Sir Charles is to discourse on artificial diamonds in the May Lecture of the Institute of Metals next spring.

WE publish this month an article on the geology of part of the Antarctic continent, written by a member of the Scott expedition, Dr. Griffith Taylor. A great deal is published in the public press relating to exploration of the north and south polar regions that does not help the seeker for accurate knowledge. Thus on the return of the Scott party exaggerated accounts were given of the coalfields proved to exist there. At our suggestion Dr. Taylor has prepared a useful résumé of the facts ascertained by him and his conclusions. The existence of coal deposits under the glaciers of Spitzbergen, Alaska, Victoria Land, and elsewhere affords the basis for theories relating to the history of the world, which we may perhaps review on some other occasion.

DR. G. E. Morrison, the celebrated representative of *The Times* in China, was a man of deep erudition and rare intelligence. Among his many other valuable public services was the collecting of books, papers, pamphlets, prints, and engravings dealing with the Chinese at home and abroad, and with China and her dependencies past and present, on every subject, and in every European language. The library that he formed in this way during nearly twenty years is quite unique, and it has the additional rare advantage of being accompanied by an annotated catalogue giving information about each individual book. It is a remarkable fact that, on his death, no Chinaman came forward either in public or private capacity to secure the library for his country. Instead, it is going to Japan, having been bought by Baron Iwasaki, who, by the way, is a Cambridge graduate. This incident reflects the difference between the Chinese and Japanese bent of mind.

AN unfortunate error on the part of our printers spoilt the value of the report of the Lake View & Oroya Exploration Company that appeared in our advertising pages last month. Attached to this report was a statement prepared by Mr. J. A. Agnew dealing with the various holdings of the company. Two of the paragraphs related to the Burma Corporation and the Zinc Corporation respectively. But by omitting the side head for the latter, and running all the matter into one paragraph, the printers caused a jumble of ideas. Seeing that both companies operate big zinc-lead ore-bodies the mixture of the paragraphs was not immediately obvious. We regret that an accident of this sort should happen where it did, for Mr. Agnew's statement on the company's holdings is notably straightforward and complete. In fact the policy of the company in this direction is one that might well be followed by other similar companies.

THIS issue contains an unusual amount of interesting matter relating to Cornwall. In an editorial we discuss Professor Truscott's paper, which contains an account of his researches in tin-dressing. As an illustration of the complicated and difficult nature of the Cornish problem we publish a flow-sheet of present practice at East Pool. The number of different treatments here is prodigious, and the great variety of plant is also notable, including as it does Wilfleys, Frue vanners, James tables, round frames, rag-frames, buddles, and kieves. Another article describes the new type of slime table invented by Mr. M. T. Taylor, the manager at East Pool. This machine combines advantages found in both the round table and the rag-frame, and introduces several interesting novelties. Finally our Cornish correspondent calls attention to the steps taken in Cornwall to forward the continuance of tin research on a working scale.

OIL engineers are often called on to face dangers due to the inflammability of the material they are handling. Those in charge of the Tembi pumping station of the Anglo-Persian Oil Company had a terrible experience a few months ago. One of the valves burst, and as the pressure at this point was 700 lb. per square inch, a great fountain of oil was thrown to a great height in all directions. The burst occurred within 30 yards of the steam-raising furnaces, so that it was imperative to stop the pumps and to cut-off the supply of oil to the furnaces, if the plant and the adjoining native compound were to be saved. Mr. R. L. Lindsay, the superintendent, rushed through the shower of oil to the furnaces, and had succeeded in turning one of the cocks when the oil took fire and burnt him to death. His assistant, Mr. James Still, had in the meantime disconnected the steam supply to the pumps. Though scorched and nearly suffocated he escaped from the building, on the completion of his duty. The courage of these two men prevented a conflagration which would have destroyed much life and property.

IN order to provide a means for eliminating German influence in non-ferrous metal production and dealings in the United Kingdom, the Government is proposing that those participating in these trades and industries shall be required to obtain a Board of Trade license. This regulation is to last for the duration of the war and for five years thereafter. Licensees will have to place their documents and books at the disposal of the Government Department for inspection. Many people feel that this method of waging commercial war on the enemy will involve unintended hardships and inconveniences in other directions, and there is opposition to the measure in Parliament, owing largely to the witholding of information as to the details of the license. For ourselves we think that a little publicity in the metal trades would do no harm to the producers and users, or to the community generally.

SCOTLAND has large undeveloped resources of water power suitable for the generation of electric current, but vested interests among the salmon-fishers and deer-stalkers have hitherto prevented their utilization on any great scale. But the war brings home the stress of circumstances to the Scottish landowner, and he is more ready nowadays to listen to the offers of the industrialist. The British Aluminium Company had a hard fight in the old days before it was able to erect hydro-electric installations at Foyers and Kinlochleven. It does not appear that there are the same obstacles in its way in connection with the new scheme whereby the scale of operations is to be vastly expanded. This proposal involves the utilization of the waters of Lochs Treig and Laggan at the head of two branches of the Spean river, which flows westward around the northern slopes of Ben Nevis. In both cases dams will be built to enlarge the lakes and regulate the outflow. Tourists passing through Inverness county will remember Loch Treig, for the branch of the North British railway connecting Glasgow with the head of Loch Lomond and thence to Fort William passes along its shores.

THE late Sir Starr Jameson, once popularly known in days gone by as "Dr. Jim," was one whose character and achievements formed the subject for an unusual amount of discussion and variance of opinion. To his admirers he was a hero and born administrator; to others he was a mere adventurer. In this way he resembled his old friend and chief, Cecil Rhodes, who similarly had his ardent supporters and violent detractors. No useful purpose can now be served by reviewing the episodes of twenty to thirty years ago, whether it be the Matabele campaign or the Jameson Raid; suffice it to say that if the raid had succeeded, the Empire would have been as ready to accept its fruits as it was to absorb Rhodesia. His later life was on more orthodox lines, and the colours of the picture were more subdued. It speaks much for his character that after his boisterous early days, and after having been condemned to death and serving a period of imprisonment, he should become a successful Prime Minister of Cape Colony and subsequently chairman of the British South Africa Company.

What are Ore Reserves?

Every now and then the necessity for a standardization of terms in mining arises for discussion. We have had, for a long time, an intention of publishing a glossary of mining terms, but owing to the difficulty of finding universally acceptable definitions of even the most elementary of words such as "ore," "level," and "reserves," the appearance of this book promises to be indefinitely postponed. With regard to the word "reserves," a good example of its different applications was provided by a paragraph on Kyshtim in the Review of Mining last month. Here it was stated that the reserves at the several mines belonging to this company were estimated at 395,416 tons. Forthwith came inquiries from readers asking where the rest of the 2,535,000 tons mentioned in last year's report had gone. The answer is that the word "reserves" is used in two different senses by the Magazine and by the engineers of the Kyshtim Corporation. Our own practice is to employ the word to connote the proved ore, blocked-out by development, and ready for extraction, whereas the Kyshtim engineers include also the ore indicated by bore-holes. The bore-hole results at these mines show that the ore-bodies go down to a certain depth, and warrant the estimate of the existence of another two million tons of ore; thus a very different figure for the "reserve" is obtained from that given by us last month. But after all, the bore-hole results are only an indication of future prospects. For ourselves we believe it is best to restrict the use of the word "reserves" to the ore blocked-out; it is the safest policy and least open to abuse; and moreover it is, on the whole, the current practice. In the case of the mines on the Rand, the "reserve" represents the ore that is proved to be worth working, and does not include any undeveloped ore, though by intelligent anticipation a fair guess might be made of the amount of ore remaining in the undeveloped area of each mine. If the origin of a word or of its particular application is investigated, assistance is provided in defining its present meaning. When the word "reserves" was first used in mining, it meant the ore on which the mill could definitely rely while further prospecting and development of probable and possible ore was in hand. Our own definition of the word conforms with this idea, and we shall let it stand.

Issuing Shares at a Premium.

The change in financial conditions caused by the war has exposed many weak points in our time-honoured methods and customs. We have already referred to the exposure of the fallacy of distributing dividends without due thought to the redemption of capital, a fallacy which would never have been admitted by the majority of controllers of mining companies if it had not been for the forcible prods given by the collectors of income tax and excess profits duty. Another old custom that is giving its followers an uncomfortable time is the issuing of share capital at a higher price than the nominal par value. One of the inconveniences resulting at present from such a practice is that a high rate of dividend paid on the par value leads to a suspicion among the public that the company is profiteering. A notable instance of this is provided by Brunner, Mond & Co. Limited, the chemical manufacturers, of Northwich, Cheshire. This company has always been directed on sound financial lines, and the accounts have never been allowed to become encumbered with assets of doubtful value. Technologically the processes are excellent, and, from the commercial point of view, the directors are keen for a market advantage and for the arrangement of profitable contracts. In order to strengthen the cash position of the company, funds were accumulated in several ways, and at present the reserve fund, nearly all used in the business, stands at two million pounds, as compared with 4½ million pounds of capital reckoned at its par value. New shares have at various times been issued at high premiums, and when other businesses have been absorbed the shares given therefor have been entered in the company's books at par value and not at the actual market value of the shares issued as payment. Altogether the company is in a snug and sound position, and the holders of the ordinary shares have been enjoying the receipt of dividends averaging 27½% on the par value of the shares. But to the agitator who has the profiteering bee in his bonnet this 27½% is a shocking thing. To some people big returns appear to be synonymous with wrong-doing. We well remember the early days of the Empire Theatre in Leicester Square when the 60% dividends were to the Macdougalls and Chants proof positive that the place was a den of infamy and a sink of iniquity, although they were really attributable to modest capitalization and intelligent management. The pressure in this direction is so great in the case of Brunner, Mond & Co. that the directors are now desirous of rearranging the capital in such a way that the par value of the shares shall be more nearly representative of the cash put into the business, or paid by shareholders when acquiring their holdings. At the present time the market quotation for ordinary shares is about 4½, so that the return on money invested in a purchase would be 6%. Whether the Treasury will sanction the issue of four new shares of £1, in place of each £1 share held at present, remains to be seen.

This incident brings once again to our notice the much debated question of issuing shares at a premium and entering their value in the books of the company at the nominal par value. Such a custom is founded on a desire to work safely and with caution, but it has the disadvantage of incorrectly representing the actual state of affairs. It is a practice regularly adopted by mining companies, and it leads to misapprehensions as to the rate of dividend distributed and also the total amount of capital put into the property. For instance, the South Crofty shares are nominally worth 5s., but the shares issued to provide working capital were sold at a premium of 300%. Thus the £40,000 of working capital is represented in the books of the company at only £10,000. It may be imagined that the holders who paid the big premium are not particularly excited over the fact that the 5s. share is now quoted at 21s. 6d. Another instance of the issue of capital at high premiums is provided by the Mysore Gold Mining Company. In this case the original capital was £135,000, of which £45,000 represented share interest, and the remainder cash subscribed at par. Since then shares having a nominal value of £137,500 have been issued at various times for a total of £645,000. The premium at each issue has varied from 100% to 1,100%. Thus the capital outlay is not reflected in the nominal capital of the company; and, as regards the return to shareholders, it has to be remembered in connection with the present quotation of £3 odd for each 10s. share that some of the shares were sold at £6 each. Our readers may expect us to advise how these difficulties and disadvantages due to the issue of shares at a premium may be obviated. We would therefore say that companies having liberal cash resources should pay for extensions of operations by their means instead of issuing new shares; that new companies with no cash should arrange their nominal capital on a scale commensurate with the prospects; and that, when shares are to be issued on the acquirement of a new business or property, opportunity should be taken to rearrange the nominal capital so as to bring it to its actual and real value. But in any case the onus is on the accountant to keep the accounts in such a way that his books shall give the proverbial true and correct view of the state of the company's affairs.

Tin-Dressing Problems.

The first results of researches relating to the problems of tin-dressing undertaken under the patronage of the Privy Council Committee by the Institution of Mining and Metallurgy and the Royal Cornwall Polytechnic Society were presented in a paper by Professor S. J. Truscott at the November meeting of the Institution. A great many of us envy Professor Truscott for the opportunity afforded him of conducting investigations as to what really happens on a slime table. The present editor of this Magazine spent much time in Cornwall some years ago studying the physical nature of tin ore in its relation to concentrating problems, but he found so much confusion of counsel among the various tin-dressers and so general a disinclination to admit the possibility of improvement that he felt he would never grasp the fundamental principles unless he had the chance of quietly conducting experiments on his own account, starting with the simplest of ideas and apparatus. That chance never came, so that the evidence of tin losses that he had collected remained inductive rather than direct. It is with unusual pleasure, therefore, that he welcomes the work recently done by Professor Truscott and his assistant, Mr. J. H. Goodchild, at the Royal School of Mines. Professor Truscott has approached the subject on perfectly logical lines, and, though some of the mine managers may refer to the investigations as "academic," the results are important in their application to practice. Like many other new departures in this country during the last year or two these researches owe their inception to the awakening of the nation to the necessity of improving detail and of leaving the old ruts into which our inertia had brought us. At the same time it is only right to say that the necessity for systematic endeavours to improve tin extraction was recognized and preached before the war by certain Cornish mining men, for instance, Mr. William Thomas and Mr. Josiah Paull. Indeed, Mr. Thomas's paper on losses in tin-dressing, read before the Cornish Institute in April, 1913, constitutes a classic, and reference will be made to it many times in years to come on account of its enumeration of the great number of ways in which tin is lost.

Professor Truscott's experiments so far have been confined to the plane inclined surface characteristic of the rectangular buddle or rag frame. He tried various materials for the surface, and tested them at varying slopes. The materials used included wood, linoleum, rubber, cement, and fluted and frosted glass. He found that when a plane surface was used the nature of the surface had little or no influence on the extraction obtained; but on the other hand the fluted glass surface when employed with judgment effected a substantially higher saving. This is his first important result and it will receive close attention in its application. As our readers are aware, we devoted a large amount of space two years ago to the consideration of the Morley Martin round frame formed of fluted glass. From the point of view of an inventor, the application of fluted glass surfaces to dressing plants is distinctly unfortunate, for older patents exist which make it necessary for him to confine his claim to one particular mode of application. Thus Mr. Martin worked solely on the round frame, and here he was confronted by two practical difficulties; in the first place he could not vary his slope, and second the juxtaposition of a number of flat surfaces arranged round a circle caused guttering at the junctions with a consequent rush of pulp and loss of material. The use of fluted glass on a rectangular buddle would involve some alteration in the present mechanism of the automatic rag-frame in order to effect the removal of the accumulated concentrate from the riffles. But we take it that Professor Truscott does not necessarily intend that such an application of the glass should be made, the object of his research being rather the general than the particular. Here it is appropriate to mention also that many engineers fall into an error with regard to the use of fluted glass surfaces on reciprocating tables such as the Wilfley. It is necessary to remember that the functions of riffles on tables and on buddles or frames are entirely different; on a table the function is to spread out the bands of the various constituents of the ore by making the heavier parts travel farther along the table and so to effect cleaner cuts at the edge; while on the buddle or frame the object is to arrest the travel of the heavier parts entirely.

Professor Truscott started the series of experiments with the simplest possible pulp, namely, one of which he knew the exact constitution and the condition in which the constituents existed. This was prepared by mixing finely crushed Nigerian tin concentrate with quartz slime - residue from a Mysore cyanide plant. The results obtained with this material showed that the tin was caught much higher up the surface than the Cornish tin-dresser usually supposes. This led Professor Truscott to deduce that the sloping surfaces on frames and buddles as employed at present are unnecessarily long and that the concentrate produced is diluted with poorer material caught lower down the surface. Upon this deduction was eventually founded his general principle for the reorganization of Cornish practice to be referred to later. For ourselves we think that this rapid arrest of the tin was due to the fact that the cassiterite and the gangue in this synthetic ore are entirely separate, and that there is no middling whatever consisting of particles containing infinite variations in the relative proportions of cassiterite and gangue. One of our deductions from the rapid arrest under these conditions is that cassiterite is not the slippery mineral that it is often alleged to be, and another is that undue sliming in the stamps need not be feared, as far as the particles of clean cassiterite are concerned.

We have said that, basing a judgment on the arrest of the cassiterite in the upper portions of the inclined surface, Professor Truscott is prepared to recommend an entire remodelling of Cornish dressing practice. The system adopted in Cornwall has always been to work up to a high-grade concentrate gradually, taking care at each stage to obtain as high an extraction as possible rather than to secure a rich concentrate. An excellent example of this practice is given elsewhere in this issue, where the East Pool flow-sheet is reproduced. Professor Truscott advises that these two conditions should be reversed and that at each stage the recovery of a rich concentrate should be the objective, leaving the tailing to be re-treated as many times and in such manner as necessary. We take it that this idea will form the basis of the further series of experiments which are to be conducted with the funds subscribed at the various meetings held last month. The idea of course is not a new one, for the basis of all dressing practice, even with tin, is to extract those parts that are easily extractable as rapidly as possible. In applying the broad principle to tin-dressing it is necessary to consider it from the point of view of the average tin lode from surface downward. Near the outcrop, the cassiterite is coarse enough for the use of jigs and a treatment on sand tables to follow, but as the size of the cassiterite particles diminishes with depth, it becomes more difficult to separate them by crushing from their accompanying gangue without making an unsettlable slime. Thus the problem gradually changes into one of preventing loss in tailing rather than the extraction of pure cassiterite. Just where the application of one principle should give way to that of the other is the debatable point in Cornwall, and the gist of Professor Truscott's argument is that the first should be carried a little farther. The problem is, however, rendered more complex by the presence of wolfram and many members of the pyrite family, and by the necessity of roasting to remove the sulphur and arsenic, but as this factor in dressing is not now being investigated we pass it over for the present.

In order to compare the efficiency of concentration results, Professor Truscott has inaugurated an empirical formula consisting of two variables. The two aims in dressing are, first, to secure a high percentage of recovery, and, second, to obtain a high-grade concentrate. As we have said, Professor Truscott considers the latter the more important of the two, so in his formula he uses the square of the variable, using as the variable the percentage of tailing to the original ore. Thus to obtain a gauge of the efficiency he multiplies the percentage of recovery by the square of the percentage of elimination of tailing. This gives a mathematical representation of his principle of the rapid removal of high-grade concentrate, and the formula will be accepted or not according to individual preference for his suggestion as compared with the standard practice of guarding against losses in the tailing. It must be remembered, however, that the formula represents no absolute fact but is only to be used comparatively.

As we have already said, the investigations so far conducted are but the preliminaries for more extensive research on a larger scale. It is obvious that any revolutionary improvement in the water-concentration of disseminated ores cannot be expected. The "porphyry" copper men never succeeded in obtaining over 65% recovery by this means, and it is no disgrace to the Cornish tin-dressers that they do not do better than this. It is well worth while to test any serious suggestion that will increase the recovery to 75%, though it is, on general principles, not advisable to try to push a process beyond its known economic limits. Cyanide came to the rescue of amalgamation in gold metallurgy, and flotation for copper, zinc, and other sulphide ores. Similarly some entirely new process will be required before tin and wolfram recovery in Cornwall passes 90%. Our own view of a possible solution, as far as tin is concerned, is based on the production of a 25% concentrate, volatilization as chloride by the Richards process, and the electrolysis of the chloride solution. Possibly this process or an analogous one has already formed the subject of experiments by our metallurgists.

The Accuracy of Chemical Balances.

At a recent meeting of the Chemical Society, Mr. Bertram Blount, the well known consulting chemical engineer, of Westminster, brought forward the subject of the accuracy of chemical balances. His argument was that no balance at present on the market preserves sufficient accuracy for delicate investigations for longer than a few months, and that, therefore, for extended investigations lasting a year or so, the balances do not come up to the scientist's modern requirements. The particular instruments he was using were intended for carrying either 100 or 200 grammes in each pan, and were guaranteed to be accurate to one-tenth of a milligramme. The results tabulated in his paper show, however, variations from 0·4 to 1·6 milligrammes over a period of four months. He was unable to find the cause to which these variations could be attributed. He concluded his paper by urging the makers of instruments to renew their efforts to produce a balance that will remain accurate for a year, and he invites the physicists to investigate the possible causes of the irregularities he describes. We have read Mr. Blount's paper several times, and find it difficult to follow his arguments, owing to the fact that he does not tell us the purpose for which he was using the balances. It is of course perfectly well known that a balance will not preserve its accuracy indefinitely. A careful man will test his balances by oscillation or otherwise every day, and will have them examined and readjusted by the makers at intervals of say one month or three months according to the uses to which they are put. On the face of it there is no reason why Mr. Blount could not protect himself in this way, and we can only surmise that perhaps the material treated never left the pan. If the latter is the case a change in the material and not a change in the balance may have caused the variations. Dismissing, however, this possibility, we are left with the two suggestions made by Mr. Blount. In the first place internal stresses in the beam may cause a slight flexure or elongation of one arm. Such alteration might be induced by the charges in the pan during the short period of weighing, or it might be due to the beam's own weight. The second possible explanation is that some accidental movement of the end knife-edges may take place. Some of the balances in use in Mr. Blount's experiments had their knife-edges set in sealing-wax, others were held by set-screws, and other knife-edges were pressed in. Mr. Blount inclines to the belief that the mounting of these knife-edges provides the explanation of the variations. In looking through the detailed figures of variation as given by Mr. Blount, we find that they follow no apparent sequence. If the variations were due to either of the causes mentioned by him the error would be gradual and cumulative, whereas the actual figures show that, with the exception of one instrument, the variations are alternately plus and minus. This is as far as we can get on the basis of the information given by Mr. Blount. The position could be more intelligently discussed if he would tell us the conditions under which the instruments were used, the nature of the investigations, and the reason why adjustments could not be made during their course.

REVIEW OF MINING

Introductory. — The anarchy in Russia, the peril of Italy, and the set-back at Cambrai have combined to cast gloom over the mining market this month. Attempts are being made in America to steady the price of silver, and it is hoped that some agreement may be settled between the American and British Governments with this object in view. Owing to severe shortage of tin supplies, the price of the metal has continued to advance, and now stands at over £290 per ton. In technological matters the item of chief interest has been the arrangement whereby the Cornish tin-dressing research is to be continued on a working scale at the mines.

Transvaal. — The output of gold on the Rand during November was 698,271 oz., and in outside districts 24,568 oz., making a total of 722,839 oz., worth £3,070,426, as compared with 724,846 oz., 26,444 oz., 751,290 oz., and £3,191,279 in October. The number of natives employed at the gold mines at the end of November was 169,083, as compared with 170,331 at the end of October and 196,132 at the end of November 1916. The number has kept remarkably uniform since the middle of the present year. The Union Government has recently granted permission for the importation of more natives from north of 22° Latitude provided they are inoculated against pneumonia.

It will be remembered that only two of the four areas in the Far East Rand offered on lease a few months ago were tendered for on terms acceptable to the Government, namely, Springs-South Geduld, and East Rietfontein. One of the other two, West Rietfontein, has again been publicly offered. The only change in the nature of the advertised terms is that the area shall be worked separately and not amalgamated with another property. Presumably the Government is jealous of Consolidated Mines Selection getting too big a slice of the Far East Rand. Undoubtedly West Rietfontein could be worked more profitably conjointly with Springs and East Rietfontein, but this arrangement would mean that Consolidated Mines Selection would have control of 20 miles of ground from Brakpan to Daggafontein. The new terms would also hit Barnatos in connection with Springs-South Geduld, and it would prevent an amalgamation with Vlakfontein which belongs to the Lace group.

We mentioned last month that the scale of operations at Sub-Nigel, in the Heidelberg district, are to be expanded by the sinking of a vertical deep-level shaft and the acquisition of adjoining ground on the Grootfontein. Full details have now been published by the Consolidated Gold Fields of South Africa. For some time it had been known that developments in depth at the Sub-Nigel were giving improved results, and as in the meantime the true significance of the Far East Rand basin was becoming better understood, Mr. C. D. Leslie, the Gold Fields consulting engineer, considered it opportune to recommend an expansion of operations. To develop the remaining 500 claims of the company's property economically, it will be necessary to sink a new vertical shaft. By increasing the monthly output from 9,000 or 10,000 tons to 17,500 tons, much cheaper working costs can be secured. The amount of ore in the claims is estimated at 2,750,000 tons, averaging 43s. 6d. per ton, and the working profit is estimated at 15s. 6d. per ton. Mr. Leslie believed, however, that better returns on capital outlay would be secured if additional ground were obtained, and he has recommended that another 500 claims should be purchased from the Grootfontein. Then the monthly output could be raised to 27,500 tons, and the profit to 19s. per ton. This extended scheme was eventually adopted by the directors. The farm Grootfontein belongs to the Gold Fields, but it has not yet been proclaimed, so steps are to be taken with that object in view. In that case the 500 claims will constitute the mynpacht which accrues to the Gold Fields as owners of the land. In order to finance the new venture, 300,000 shares are to be issued, to be offered first to present shareholders, but guaranteed by the Gold Fields. This will provide working capital for shaft-sinking. As regards the purchase of the Grootfontein ground, £130,000 in shares will be issued in three years time, the postponement being partly because the property is not yet disposable, and partly in order that the current profits of the old property shall not be distributable among the owners of the new property until the latter is approaching the workable stage.

Some time ago we recorded that Mr. G. R. Bonnard had made an agreement with Oceana Development whereby he undertook to bore on the company's farms, Eendracht and Koppieskraal, to the south-west of the Far East Rand basin, but that subsequently, after taking the advice of certain mining engineers, he had abandoned the undertaking. It is now announced that Dr. Hans Sauer, of bygone Rhodesian fame, has contracted to sink these bore-holes. The expectation of finding a banket bed is founded on Mr. W. E. Bleloch's theory of the geology of the Far East Rand, but, as we have repeatedly said, Mr. Bleloch stands isolated with regard to Rand geology. The contracts made between Oceana Development and Dr. Sauer provide for a big company should the results of the boring be satisfactory. We shall give these financial details if and when the hopes materialize.

Rhodesia.—The yield of gold during October was worth £289,978, as compared with £291,367 in September, and £325,608 in October, 1916. The outputs of other metals and minerals were: silver 17,134 oz., copper 273 tons, wolfram 1 ton, coal 53,916 tons, asbestos 712 tons, diamonds 80 carats.

The Globe & Phœnix company now issues quarterly reports relating to developments. During the three months ended September 30, 493 ft. was driven or sunk; of this, 80 ft. averaged 11 dwt. gold per ton over 30 in., 105 ft. 19 dwt. over 31 in., 134 ft. 14 dwt. over 35 in., and 91 ft. in winzes and rises 18 dwt. over 33 inches. The ore disclosed is of considerably lower grade than the reserves, which stood on June 30 at 187,161 tons averaging 29·2 dwt. The company is actively developing a copper-gold lode not far away from the mine. The shaft has been sunk to 120 ft., and drifts east and west have been started. In the east drift the present face averages 5·3% copper and 1 dwt. gold over 48 in. In the west drift the face, 25 ft. from the shaft, averages 8·2% copper and 1·5 dwt. gold.

Congo State.—The report of Tanganyika Concessions now issued covers the year 1916, but it also contains some later information relating to the copper output at the Star and Kambove mines. The sixth blast-furnace is ready to start, and the seventh is in course of construction. When the seven furnaces are running at full capacity they should produce 40,000 tons of copper per year. The output for 1917 until the end of October was 23,013 tons, as compared with 22,149 tons during the whole of 1916. The Belgian company, Union Minière du Haut Katanga, which works these mines, and in which Tanganyika Concessions holds 40% interest, is still unable to present a balance sheet, hold a meeting, or declare a dividend, so the shareholders in the English company cannot yet participate in the big profits accruing from the sale of copper. As is usual, the directors' report is not a lengthy one, but the details of the business are given in the speech of Mr. Robert Williams, the managing director, which is reported on another page.

West Africa.—The output of gold during October is reported at £126,295, as compared with £127,168 in September, and £132,577 a year ago.

Developments during the past year have added to the reserves of the Ashanti Goldfields. The reserve in the Obuasi shoot is estimated at 419,100 tons averaging 28·4 dwt., as compared with 327,600 tons averaging 29·9 dwt. a year ago, and 266,900 tons averaging 28 dwt. the year before. An interesting feature in connection with recent developments at the lower levels has to be noted. The Ashanti fissure which, in the north-east sections of the mine, carries the main Ashanti Reef, strikes N. 30° E. with a south-easterly dip of 76°. The Obuasi fissure, striking N. 55° E. and dipping north-west at 65°, intersects the plane of the Ashanti fissure, and the line of intersection or junction pitches N. 40° E. at an angle of about 45°. In the upper levels of the mine the Obuasi shoot, pitching parallel to the line of junction, was carried entirely in the Obuasi fissure and at some distance north-east of the junction. From No. 10 Level downwards, owing to the steepening in the pitch of the shoot, it was found to approach the junction more closely at each level. At Nos. 16 and 17 Levels it has, for part of its length, overlapped the junction and made its appearance south-west of it in the Ashanti fissure, where it bears many of the characteristics of the main Ashanti Reef. It shows, for instance, stronger walls, a steeper dip, a greater width, but a lower grade than the Obuasi shoot in its normal position. It is impossible to say what new phases will be encountered at deeper levels. On the one hand, the pitch of the shoot may again flatten and the ore be found to be entirely in the Obuasi fissure, when normal conditions would probably again supervene. On the other hand, should the steeper angle of pitch continue, an increasing proportion of the length of the shoot will be found within the Ashanti fissure.

The position of affairs at the Taquah mine is distinctly satisfactory, for the new ore-shoot discovered a year or more ago on the 10th level has been proved on the 11th, 12th, and 9th levels. A winze has been sunk on the lode below the 12th level and a 13th level is being opened to meet it, while a rise above the 9th level shows that the lode continues upward. The shoot is also to be attacked from the 5th level. These developments have fully maintained the reserve, which stands at 213,347 tons averaging 56s. 10d. per ton, equal to more than three years' supply.

Nigeria.—The Rayfield company announces that the Merten concessions, recently acquired jointly with the Niger Co., are to be sold to the Dua (Nigeria) Tin Fields, which has ample funds for the erection of treatment plant.

The Jantar company is noted for its promptness in issuing the yearly report, and for this reason deserves special mention. During the year ended September 30 last 256 tons of concentrate averaging 72% metal was produced, as compared with 261 tons the year before. During the months April, May, and June operations were hindered by scarcity of water and a shortage of foodstuffs. The concentrate sold for an average price of £150. 8s. 6d. per ton. A net profit of £15,730 was made, and £15,000 was distributed as dividend, being at the rate of 25%. We often wonder why other companies cannot issue their reports as promptly and in so concise a form.

Australasia. — At the Mount Lyell mine the smelters treated 152,668 tons of Mount Lyell ore, 82,878 tons of North Lyell ore, and 4,049 tons of concentrate during the half year ended September 30. The blister copper produced contained 5,766 tons of fine copper, 295,126 oz. silver, and 7,455 oz. gold. The strike in May involved the loss of three weeks at the mine and smelter. The flotation plant, of which a brief account is given in the Mining Digest, treated 14,129 tons averaging 2·91% copper, and produced 3,902 tons of concentrate averaging 9·31% copper.

The celebrated Mt. Bischoff tin mine in Tasmania is now working on a much reduced scale. The last half-yearly report to hand shows that 219 tons of concentrate was obtained from 52,565 tons of ore, or just about one-third of the output and of ore treated to which we were accustomed until four years ago. The ore on the southern slopes, which gave the big returns, is nearly exhausted, and the future of the company depends on working the low-grade northern slopes on a larger scale. There are also extensive deposits of detrital tin in the north valley flats. It is estimated that 850,000 tons averaging 0·3% tin is available for treatment. Heavier stamps, together with tube-mills, have recently been erected. Mt. Bischoff has been one of the great mines of the world, and for forty years paid handsome dividends on a very small original outlay of capital.

The life of the Kalgurli mine is approaching its end. The limits of the high-grade ore were indicated by Dr. Malcolm Maclaren four years ago, and for the last two years the profits have been considerably lower than formerly. The ore reserve at present is only sufficient for a few months supply, but development and diamond-drilling continue to disclose other sources of ore. Drilling in the southern end of the property is to be undertaken from the workings of the adjoining South Kalgurli. The amount of ground left unexplored is restricted, so that future chances are not great. The Kalgurli has had an excellent record, and has yielded large returns on a moderate capital.

At last arrangements have been made between the debenture holders of the Chillagoe company for the sale of the mines and railway to the Queensland Government. The payment is to take the form of £475,000 in 4½% Queensland Government bonds. The amount of the debentures is £562,000, bearing 5% interest. A meeting is to be held in London on January 3 to confirm this arrangement.

The Queensland Government is turning its attention to the deposits of iron ore within its boundaries with a view to establishing a smelting industry. The deposits that attract most attention are those at Biggenden. Mr. B. Dunstan, the Government Geologist, reports the possibility of mining 500,000 tons of ore and the State authorities contemplate erecting a 50 ton blast-furnace.

India.—At the Rakha Hills copper mine, belonging to the Cape Copper Company, progress is greatly hindered by the impossibility of obtaining supplies of coke, and a start on an adequate scale has not yet been made. The concentration plant and the blast-furnace have been ready for some time, and the latter has been running with such coke as could be obtained. A converting plant is in course of erection. Development was resumed in July. The ore reserve now stands at 407,641 tons averaging 3·71% copper over a width of 42 inches. In stoping it has been found that the ore is of a rather lower grade than was estimated. A Minerals Separation flotation plant has been added to the concentrators.

Cornwall.—The dumps of the Poldice mine in the Gwennap district, which are reported to contain tin and wolfram values in payable quantities at present prices, have been acquired by the Berrida Co., which has hitherto confined its attention to Nigeria. It is to be hoped that experience with the dumps will induce the Berrida Co. to re-open the mine, the history of which certainly warrants further exploitation.

The Rayfield (Cornwall) Tin Syndicate is a parent and holding company interested in several very promising Cornish mines, but unfortunately without capital to develop them. The report covering the four years ended September 30 last shows a debit balance of £13,047. The syndicate holds 70% of the capital of the Porkellis Tin Mines, Ltd., where, it is reported, nearly 100,000 tons of ore has already been developed, on which, with the price of tin £50 lower than present quotations, it was estimated there would be a profit of over £1 per ton. These reserves are all above the 450 ft. horizon, and they can be rapidly increased by driving east and west on the several lodes. The syndicate also has a substantial interest in the Geevor mine, owns entirely the North Dolcoath property, is joint owner of the Zennor mine, and holds a fifth interest in Killifreth. The last named property was abandoned in 1896 when black tin was only realizing £37 per ton, and even then the mine was practically paying its way. The outlook for Cornish mining at that time was dark and capital could not be secured, but there is reason to believe that the mine could have been pulled through those bad times, if the company's bankers had not acted precipitately. Locally, everyone has a great faith in Killifreth.

Canada.—An important step has been taken by the Canadian Government by buying 600,000 shares of $10 each in the Canadian Northern Railway, and thus securing the control. This company has been instrumental in developing the northern parts of the provinces of Manitoba, Saskatchewan, and Alberta. Among other districts on its system is The Pas, Mr. J. B. Tyrrell's account of which is given elsewhere in this issue.

United States.—Attempts are being made to fix the price of silver, thus following the Government action with regard to copper. Hitherto the silver market of the world has been entirely in the hands of four bullion firms in London, who keep secret the reasons for the up and down movements. Silver is largely nowadays a by-product of copper and lead mining, at any rate in the United States, and it is therefore impossible for producers to consider the reduction or increase of their output to suit market conditions. Some sort of standard price for the metal is therefore desirable from their point of view. A similar advantage would accrue to the Governments who are the forced purchasers. Here is a practicable opening for Universal Bimetallism.

We are glad to hear that the American Zinc, Lead, & Smelting Co. has come to terms with Minerals Separation in connection with the latter's claim for infringement. The amount invovled is $250,000. The company has also become a licensee for the flotation patents. The decision to come to terms was made in spite of the protest of Mr. D. C. Jackling, who has therefore resigned from the board of the company. Mr. Jackling is the leading antagonist against Minerals Separation in America.

Russia.—The directors' report of the Irtysh Corporation for the year 1916 is accompanied by a report by the engineers outlining the work of the mines during the current year. At the Ridder mine nothing could be done as it was flooded at the end of 1916, owing to the breakdown of the water-power plant and a shortage of fuel for steam purposes. The new pumps were not delivered until the summer of this year. In the meantime, attention has been paid to the Sokolni deposit in the same neighbourhood, which is of similar nature to the Ridder, containing mixed sulphides of lead, zinc, and copper with silver and gold contents. By the end of September, 7,500 tons of ore had been raised, and there was already 25,000 tons on the surface. Development has also disclosed the existence of oxidized gold ore. The estimate of sulphide ore is 360,000 tons. Under these conditions the concentrator and smelters were not very actively employed. From March to September, 6,200 tons of sulphide ore had been treated for a yield of 1,600 tons of zinc concentrate and 400 tons of lead concentrate. At the lead smelter two blast-furnaces have just started operation. At the zinc smelter, the first furnace of 360 retorts ran from August, 1916, to March, 1917, and was then stopped for repairs, which are now completed; in March the second furnace of 480 retorts was started; a third furnace is under construction, and the foundations for a fourth are completed. During the first six months of 1917, the output of zinc was 333 tons.

The reports of the Kyshtim and Tanalyk Corporations for 1916 have been published. Owing to Russian disorganization the Kyshtim accounts for 1916 have not come to hand. In the Tanalyk report the most interesting feature is the information relating to the Tuba gold mine. In depth the oxidized ore is found to change to pyritic ore. The ore-body appears to be irregular in shape and content, but the assays quoted promise considerable quantities of auriferous copper ore.

ANTARCTIC GEOLOGY

By GRIFFITH TAYLOR

D.Sc. (Sydney), B.E., B.A. (Cambridge), F.G.S., F.R.G.S.
Senior Geologist on Captain Scott's Expedition 1910-14 and Leader of the Western Parties.

The author describes the geology of part of South Victoria Land, and gives information relating to coal deposits found there. These deposits are about as far distant from the South Pole as those of Spitzbergen are from the North Pole

General Geology.—Captain Scott's last expedition was numerically strong in geologists, who were all to some degree associated with the geological schools of Cambridge or Sydney. Thus in the Northern Party was Raymond Priestley, primarily from Bristol (whence he had accompanied Shackleton in 1907) but later of Sydney and Cambridge. In the Ross Island Region were Frank Debenham of Sydney (and later of Cambridge) and myself who was appointed from Cambridge. Charles Wright (of Toronto and Cambridge) specialized in the physical aspect of the ice problems and was a member of the Polar Supporting Party. Dr. Wilson (also of Cambridge) was a keen observer of physiographic features, and made many sketches of the land forms on his last journey. To him also we owe the unique Gondwana Land Flora from the head of the Beardmore Glacier. Our leader was an amateur geologist with great critical powers, as I have described elsewhere, and his paper on the structure of the Ross Ice Barrier (recently published by the Royal Geographical Society) shows that he had given much thought to some of the most important questions in Antarctic geology.

The problems which confronted us in 1910 can be sub-divided into those of stratigraphic and physiographic geology respectively. H. T. Ferrar and others had shown the main features of the stratigraphy; but the major principles underlying the relation of ice and land had not been described in any detail at the time of our Expedition. The descriptions which follow refer primarily to those investigations carried out around the south-west of the Ross Sea by the Western Parties in 1911 and 1912.

Captain Scott arranged that the southern geologists should work independently of other exploratory work, and his choice of our field of work proved to be fortunate. Ferrar in 1903 had made a very complete geological reconnaissance of the great ice valleys (Ferrar Glacier, etc.), leading up to Ice Plateau from Butter Point (see Fig. 1). Here his rock material was largely confined to the towering cliffs bounding the great glaciers. Priestley in 1907 had covered much the same ground. David and Mawson had done their major work much farther north in the valleys leading up to the magnetic pole.

The new areas geologically surveyed by Debenham, Wright, and myself in the first summer (1911), comprised the Taylor Valley and the Mount Lister Scarp Valleys. *En route* we traversed the Ferrar Glacier, where we were able to supplement earlier work. The special feature of these two areas was the fact that, though they were situated in 78° S. latitude, they were almost as free from ice as the valleys of Switzerland. As I shall show later, it was their close resemblance in topography to the latter which constituted their special interest for the physiographer. Each of these areas of bare rock and moraine was approximately twenty-five miles long and some five miles wide. Practically none of this had been traversed by a geologist, except the coast of New Harbour.

I propose to describe the chief geological features in these regions and in Granite Harbour (surveyed in 1912) in some detail, as there is no doubt that they are representative of almost all the chief problems of East Antarctica. Two other districts—the volcanic massif of Mount Erebus near our headquarters, and the sediments at the head of the Beardmore Glacier—also merit special attention.

The Antarctic coast in the vicinity of the 1910 headquarters at Cape Evans (see Fig. 1), exhibits a comparatively simple topography. Inland it consists of an elevated plateau of some 7,000 ft., whose upper layer is a permanent icefield, which is probably one or two thousand feet thick. The great range of mountains fringing the plateau reaches to 13,000 feet in Mount Lister. The summits are only ten or fifteen miles from the sea, and this coastal divide I have compared elsewhere to the similar occurrence in north-east Australia. As in the latter example, the actual coast line marks an extensive development of major faults, the downthrow side being in both cases to the east. This "senkungsfeld" accounts for MacMurdo Sound and probably for the Ross Sea also.

Luckily for the geologist this great scarp, rising to 10,000 ft. all along the Royal Society

FIG. 1. MAP OF THE PART OF ANTARCTICA DESCRIBED.

A-B=Line of section in Fig. 2; C=Cape Bernacchi; D=Davis Glacier; W=Walcott Glacier; L=Mt. Lister, 13,000 ft.; S=Mt. Suess.

Range, is deeply notched by the numerous outlet glaciers. Here free from all vegetation, and to a considerable degree free from the soil-covering of weathered rock, wonderful sections of the various terrains are exhibited. The giant cliffs bounding the outlet glaciers usually reach three or four thousand feet in height. They slope in general at an angle of about 33°, probably because this is the angle at which frost chips begin to coat the cliff faces and protect them.

Let us imagine ourselves sledging up to the great plateau along the line of the Taylor outlet glacier (see Fig. 2).

Cape Bernacchi is a low promontory which forms the northern portal of New Harbour. Here a reef runs into the sea, composed of contorted schists and gneisses. Coarsely grained marble is included in these massive metamorphics, and here a few specimens of pyrite were discovered. Since similar rocks occur in other parts of the Antarctic below Archeo-cyathinæ limestones of Cambrian age, we may with some reason compare them to the similar association in South Australia. Here these metamorphics are relegated to Pre-Cambrian times.

The rounded hills such as Hjorthis Hill (reaching about 3,000 ft.) which fringe the north coast of New Harbour are composed of schistose granite. I climbed this hill and found that the cleavage planes ran north and south, while dykes of darker and more foliated rock crossed the general strike. Here also occurred highly altered beds of marble.

Ten miles or so to the west is the head of New Harbour. Here are the ancient terminal moraines of the Taylor Glacier which cover the floor of the valley and prevent a clear view of its geological structure. However, the cliffs at the side exhibit similar schistose granites, and probably the floor is of the same type, or has a stronger metamorphic facies as at Cape Bernacchi (see Fig. 2).

After a rough tramp over the ice-free valley for ten miles, we reached the foot of the extraordinary rock-bar (or "riegel") which almost blocks the whole width of the glacier trough. It rises to a height of 2,400 ft. in the middle of the valley, and is breached only by a narrow defile (occupied partly by Lake Chad) along the northern side.

Here again the same type of ancient granite was met with, but included in the series of schists and gneissic granites was an interesting bed of limestones and slates. Their strike was apparently almost north and south, and the beds were approximately vertical. These beds unfortunately had been so altered by metamorphism that there was no hope of obtaining fossils, even if such had been contained in them.

I felt that this was a good locality to use the prospecting dish which I had purchased in Dunedin with a view to testing the value of Antarctic gravels. The shores of Lake Chad consisted of gravels washed down into the defile from the Nussbaum riegel. There were numerous quartz leads crossing the slates, and though they were not of a kindly appearance, yet the juxtaposition of the limestones with the granite was a promising indication. Moreover, there was abundance of water in the lake nearby, to be obtained by breaking the layer of covering ice. I washed out many pans of dirt. The concentrates of heavy sand were not promising, for I could hardly discover any magnetite or pyrite. Of the precious metal there was no trace, and as I expected to find no water on the remainder of our explorations I left the gold-seeker's pan on the shores of Lake Chad.

After passing up the defile, which is three miles long, one enters a broad basin where the trough expands again to a width of two or three miles. The explanation of the unusual topography in this district will be given later. The local drainage among the ground moraine is here away from the coast, that is up valley into Lake Bonney. Broad sloping terraces flank this portion of the valley, and tributary glaciers hang over the shoulders, sometimes fed merely by avalanches falling from the snowfields near the summits of the ranges. Five miles of this open valley brings us to the snout of the Taylor Glacier. So far we have not risen much above sea level, and have probably kept much about the same geological horizon, that is, the top of the Pre-Cambrian schists and base of the grey granite.

The walls of the Taylor Valley, rising to 6,000 or 7,000 ft. at each side, are composed largely of a massive-grey or reddish-grey granite. But about this longitude three new formations make their appearance, for higher members of the sequence are coming into view. The summit of the Matterhorn—a conical peak 5,000 ft. high—consists of quartz-dolerite, which weathers into pinnacles and is marked by strong vertical jointing. As we proceed farther west, and the mountains are higher, this dolerite is found to occur in two or more vast sills. These have intruded the granite and are obviously of much more recent geological age.

Perched on the eroded shoulders of this great glacial valley are several dark irregular knobs which, from the valley below, closely resemble heaps of black slag. Debenham climbed up 2,000 ft. to one of these, and found it to be a wall of basic lava, 80 ft. high; and obviously of post-glacial age, since it lay like a wart on the smooth glaciated shoulder. Across on the north side of the valley, 2,000 ft. above the snout of the Taylor Glacier, was a fine exam-

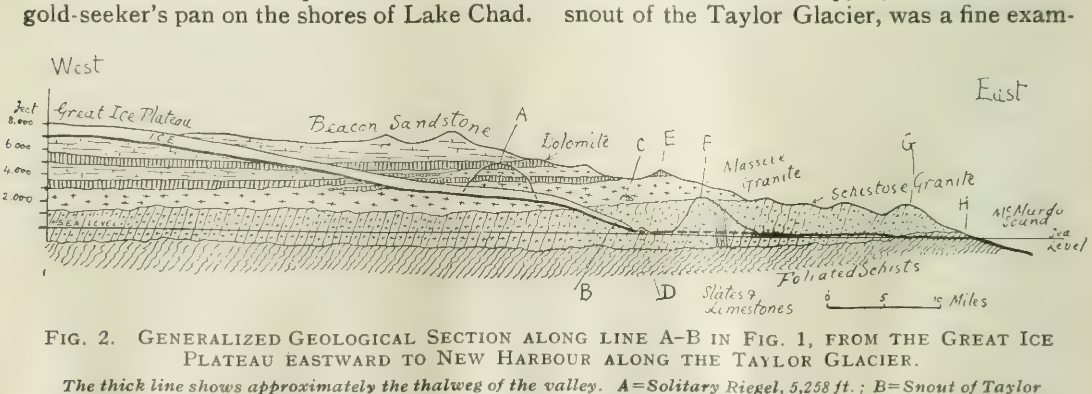


FIG. 2. GENERALIZED GEOLOGICAL SECTION ALONG LINE A–B IN FIG. 1, FROM THE GREAT ICE PLATEAU EASTWARD TO NEW HARBOUR ALONG THE TAYLOR GLACIER.

The thick line shows approximately the thalweg of the valley. A=Solitary Riegel, 5,258 ft.; B=Snout of Taylor Glacier; C=Recent Basalt Crater on Slope; D=Bonney Riegel, 500 ft.; E=Matterhorn, 5,000 ft.; F=Nussbaum Riegel, 2,400 ft.; G=Hjorthis Hill, 2,900 ft.; H=Cape Bernacchi.

ple of a breached crater in a somewhat similar position, but this we were unable to reach. These flows are possibly contemporaneous, with the small basic puys which are so characteristic of Hut Point, to the south-west of Erebus.

Lastly, near the western end of the Kukri Hills (see Fig. 1) a series of buff-coloured sandstones is visible, perched high above all the formations mentioned previously. Hereabouts only the triangular summits between the hanging cliff glaciers are built of this sandstone, but still farther west they form continuous beds from two to four thousand feet thick (see Fig. 2).

At the north-west end of the Kukri Hills, which we visited in February, 1911, there is a splendid cliff section 3,000 ft. high, which shows very clearly the relative ages of the chief of these formations. The eastern portion of the cliff was almost wholly composed of massive grey granite, and the western portion of quartz-dolerite. The latter was here in the form of a sill, almost 2,000 ft. thick. Long narrow dykes of dolerite penetrated into the granite, while tremendous irregular blocks, apparently of Beacon Sandstone, had been torn away as the sill stoped its way up into the sediment above. Capping the dolerite was more Beacon Sandstone, which seemed to be comparatively undisturbed, though probably it had been raised *en masse* by the eruptive rock.

These quartz-dolerites have been shown by Professor Woolnough and others to be closely akin both petrologically and structurally to the dolerite sills of Tasmania. The latter are believed to be of Cretaceous age, and this age seems to agree with the meagre data in Antarctica. The southern sills are of great extent, covering at least three hundred miles from Mount Nansen to Mount Lister, while dolerites have also been described from the Beardmore far to the south and from Mawson's Base far to the north. They show just the same sill structure in the Granite Harbour region, and one of the most prominent peaks at the head of the Mackay Glacier (Mount Tryggve Gran, 6,500 ft.) has its flat top determined by the cap of dolerite (see Fig. 1). Benson describes them as composed essentially of basic plagioclose and pyroxene, chiefly monoclinic, with a varying amount of micropegmatitic intergrowth of quartz and felspar occurring interstitially.

One of the stratigraphical puzzles of the Antarctic is the age of the Beacon Sandstones. They were named in 1903 by Ferrar from the cliff sections at the head of the Ferrar and Taylor glaciers. Although several thousand feet of the sediment were exposed they all gave barren results as regards fossils. Priestley in 1907 and our party in 1911 had no better luck in this region. But in the Upper Beardmore district, some 450 miles to the southward, similar horizontal sandstones were found by Shackleton's party to contain coal seams, and in some of the specimens from Mount Buckley a woody tissue was preserved (see Fig. 3). Unfortunately it was too poorly preserved for identification, but seemed to place the Beacon Sandstones not earlier than Carboniferous times. Frank Wild described seven seams interstratified with 300 ft. of sandstone. The seams range from one to seven feet in thickness.

A sample of the Beardmore coal (analysed by J. C. Mingaye) gave the following:

		%
Hygroscopic Moisture	...	3·16
Volatile Hydrocarbons	...	14·5
Fixed Carbon ...	...	68·84
Ash	...	13·43
		99·93
No true coke formed	...	
Sulphur in coal ...	...	0·274

Professor David has estimated that there are about 12,000 square miles of Beacon Sand-

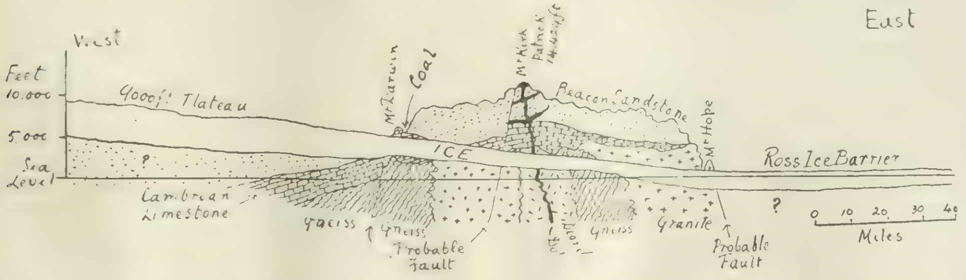


FIG. 3. GENERALIZED SECTION ALONG THE BEARDMORE GLACIER, 450 MILES SOUTH OF ROSS SEA, Showing the Antarctic Horst and the position of Mt. Darwin near which the Archeo-cyathinae corals and Gondwana ferns were found. (Slightly modified after David and Priestley).

stone actually now exposed above sea level in the plateau of the great "horst." This would represent the whole amount available for coal-mining if the coal measures were developed over the whole of the area. Unfortunately there is no appearance of coal in the Ferrar-Taylor region; but in the Granite Harbour hinterland Debenham discovered specimens of coal in a vastly more accessible position than the Upper Beardmore. We were unable to identify the actual outcrop, for the specimens occurred in the Mount Suess moraine (see Fig. 1). But in the cliffs of Mount Suess, and also a mile or two west in the walls of the Mackay glaciers, were horizontal beds of Beacon Sandstone, which fed this moraine. Hence there is little doubt that the coal would outcrop in the sediments we could see higher up the glacier, only twenty miles from the sea in Granite Harbour. The composition and field occurrences of this important find are being described by my colleague, Frank Debenham.

Of equal stratigraphic importance are the other fossils which we collected on the same nunatak in the Mackay glaciers. On our return these carinate plates were determined by Dr. A. S. Woodward to be fish plates of Devonian age. They have not yet been figured.

The fossils so heroically brought back by the ill-fated Polar Party were collected by Dr. Wilson at the head of the Beardmore in the same region as that visited by Wild (see Fig. 3). Professor Seward has described them as members of the well known Gondwana Flora, which flourished in Permo-Carboniferous times all over the Southern Hemisphere. Probably both these coal outcrops belong to the same horizon as the valuable coals of the Newcastle series in New South Wales. In the Spitzbergen region coal is being mined, and in the far future, if economic ore deposits are discovered in the promising terrains of the Ross Sea littoral, we may see the Beacon Sandstone seams adding their quota to the world's available coal supply.

It is evident that the level-bedded Beacon Sandstones imply a vast period of quiet sedimentation in Antarctica, during Devonian, Carboniferous, and Permian times. Probably large areas under the great ice cap are also covered with this series and no doubt much coal is thus lying lost in the heart of the Antarctic.

One further discovery of fossils remains to be recorded. In the moraines of the Beardmore in 1908 Wild collected a limestone breccia which contains minute organisms. Professor David handed them to me for identification, and I was able to recognize several species of the widely distributed Archeo-cyathinæ fauna. These organisms built huge coral reefs in Cambrian times. Such fossil reefs occur in Siberia, Sardinia, Nevada, and elsewhere; and especially in South Australia where they have been noted over a distance of 200 miles. Their biological position is doubtful, though I have advanced evidence suggesting that they represent an extremely ancient type of coral which in some respects is akin to the more primitive family of sponges. In 1911 Wright found a much larger specimen in the Beardmore moraines. I have sketched in Fig. 4 a restoration of these primitive organisms.

In Fig. 3 (which is taken from David and Priestley's valuable memoir) is shown the arrangement of the beds in the Beardmore region. The coal outcrops are indicated. The Cambrian fossils may have come from the Mount Darwin limestones, or from similar outcrops lower down the Beardmore Valley. It will be seen that the British Expeditions of 1907 and 1910 have brought back important fossils proving the identity of two interesting horizons in the sediments nearest the south pole.

No description of the geology of the Ross Sea region would be complete without some reference to the dominating volcano of Erebus. This towers 13,300 ft. above the sea, and together with its extinct neighbour Terror, practically forms Ross Island. Traces of three older cones are still preserved as somma rings around Erebus while the present crater is still active. Steam ascends almost continuously, but only occasionally, in the long night, did we see the glow which marks special activity. The mountain was ascended in 1908 by David and Mawson, and again in 1912 by Priestley and Debenham, and their descriptions are readily available. The main bulk of the cone is formed of the remarkable lava kenyte; but many other varieties of lava, from acid trachyte to magnetic basalts, occur also, though in smaller proportions. The kenytes are closely allied to the rhomb porphyries of Norway and to Gregory's series from Mount Kenya in East Africa. Their chief characteristic is the presence of large phenocrysts of anorthoclase, usually about one inch long. On almost all the outcrops these felspars weather out under the action of frost, so that the surface of the kenyte resembles a medieval church door studded with huge nailheads. The chief constituents are given by Prior as: silica 56%, alumina 21%, soda 7%, and potash 4%. Data as to the period of the initiation of these eruptions are wanting. They are connected with the great tectonic movements of middle and late Tertiary times in this portion of the globe, but no fossils have been discovered of Tertiary age in the Ross Sea area which might furnish the answer to this question.

GLACIAL GEOLOGY.—The geological problems which especially engaged my own attention in the field were largely of a physiographic nature. I was anxious to compare Antarctic topography with that which I have studied in the Swiss Alps, in New Zealand, and else-

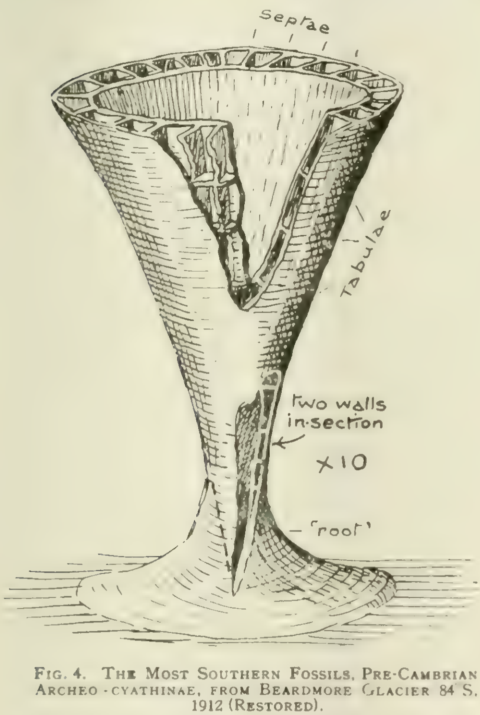


FIG. 4. THE MOST SOUTHERN FOSSILS, PRE-CAMBRIAN ARCHEO-CYATHINAE, FROM BEARDMORE GLACIER 84 S. 1912 (RESTORED).

where. A lengthy account would be out of place, but nowadays questions of glacial topography, since they closely concern problems of communications and outcrop, are interesting engineers in many parts of the world. I was greatly struck with three unexpected features in Antarctica. There was almost a complete absence of surface moraine on all the glaciers, and an equal absence of "glacier milk" (that is, suspended silt) in the drainage water from most of the glaciers. Moreover the glaciers in the region of my survey (76° 30′ to 78° 30′) were separated from the valley sides by great "lateral moats," often several hundred feet wide. When one has traversed the New Zealand glaciers, and noticed miles of surface moraine covering the lower Tasman Glacier, or the successive walls of lateral moraine pushed up the cliffs by the Hooker Glacier, one comes to the conclusion that glacial erosion is comparatively slight *under present conditions* in Antarctica. The climate is too cold. The ice is sluggish, and more important still, frost action is at a minimum.

I was more and more impressed by the great part played by "thaw-and-freeze" (nivation) in glacial erosion. This obviously needs temperatures fluctuating about 32° F.; and since the average temperature of the hottest month is some twelve degrees below freezing (20° F.) there are but a few days in the year when this condition is adequately fulfilled.

There are to be distinguished three types of glacial action, usually all present in any important region: (1) The protective ice-cap, which is negative in effect; (2) The erosive action of the greatest glaciers; to which is due the great troughs like Lake Como in Europe or the Beardmore and Ferrar troughs in Antarctica; (3) The sapping action of the ice which has produced the "arm-chair valleys" known as cirques or cwms.

A small glacier like the Mer de Glace is as poor an instrument of erosion as is a desert stream feebly dying away in the sands. But the ancient Chamounix glacier, which once filled the whole trough, was capable of erosion on a grand scale; and is to be compared with such a river as the Rhine where it cuts through the Bingen "horst."

There is little doubt, from fossil evidence in American Antarctica, that in Miocene times the whole continent was relatively ice-free. With the onset of colder conditions, thousands of years of "frost-providing climate" must have supervened. It is in this earlier stage of the glacial cycle in Antarctica, that I believe that most of the great trough excavation took place.

In Granite Harbour (see Fig. 1) we were able to measure very accurately the movement of the Mackay Glacier tongue. We found that even during the month of December it only moved seaward at the rate of a yard a day. Probably this velocity decreased almost to zero in midwinter.

Undoubtedly the most interesting physiographic features in our region were the cirques (or cwms) and the rock-bars ("riegel"). In the scarp of Mount Lister (see Fig. 1) one gigantic cirque (the Walcott Glacier) was twelve miles across, and the back cliffs were 10,000 ft. high. Many of these cirques reached the main Koettlitz Glacier by deep troughs five to ten miles long. If we compare the cirque to an "armchair," then this combined structure resembles a " lounge-chair" (see Fig. 5). There seems little doubt that these cirques have been cut out by a process of *headway erosion*, which differs totally from the planing action usually associated with a glacier.

The most difficult problem in the glaciology of the Swiss Alps, and elsewhere, is to explain the origin of the abrupt "steps," which bulk so largely in the transport problems of that

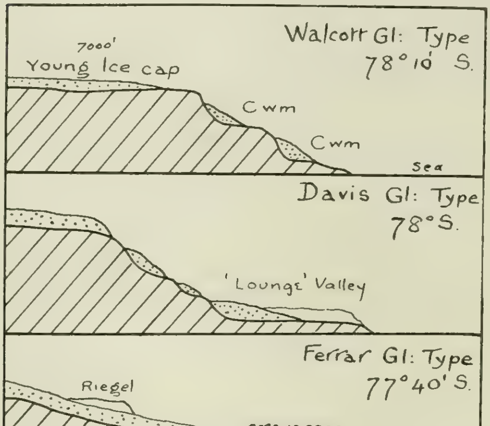


FIG. 5. ILLUSTRATING THE PALIMPSEST THEORY OF EROSION, as shown in four successive valley sections in the McMurdo Sound Region; the ice is shown dotted.

region. For instance, in the Engadine we have the broad flat trough at Saint Moritz rising slightly to the west, and then dropping abruptly at Maloja in a step of several thousand feet to the Val Bregaglia in Italy. Similar steps occur at Bergun on the Albula railway, and at Leuk on the new Simplon route, to mention only a few of the better known occurrences.

In Antarctica I was able to trace out a complete sequence in the evolution of the glacial valleys, which, to my mind, goes far to explain how most, if not all, of these abrupt steps in the course of a glacier valley originated.

In old Greek manuscripts one can sometimes discern traces of an older script half obliterated by the latter writings; this manuscript is called a " palimpsest." Just so in Antarctica. I think that beneath the largest *outlet* glaciers, such as the Ferrar and Taylor glaciers, we can perceive the relics of an earlier cwm (or cirque) erosion.

Cutting into the face of the Mount Lister scarp (here 10,000 ft. high) we see simple cwm glaciers such as the Walcott Glacier (see Fig. 5). Here, as described in text-books of glaciology, headward erosion gnaws out an arm-chair valley, in which snow and ice continue to accumulate. (It is an interesting point that in Antarctica no pressure whatever is necessary to turn a snow-drift into solid ice. Like wine it " matures " with age).

This headward erosion proceeds more rapidly at the upper portion of the ice-mass than elsewhere round its margin, so that though the " arm-chair " valley increases in size all round, the " back " is chipped away most rapidly. In this way it is converted into a " lounge-chair " valley, as shown in Fig. 5. This is illustrated in almost the next valley to the Walcott (see Fig. 1), the Davis Valley. This valley, though only seven miles long from the mouth to the steep step at its head, is two thousand feet deep, and could not have been cut by normal glacier gouging.

These small cwm glaciers, in my opinion, are the first glacial tools to attack the land surface at the onset of the Ice Age. Where this does not grip a country for any length of time, as in the Australian Alps, or in Snowdon, nothing but a few arm-chair valleys result. Where, however, long continued glaciation ensues, the upper regions of the country become more or less covered by an ice cap or continental glacier. This sends down its surplus ice to the lower levels in the form of outlet glaciers; and these naturally follow the easiest paths.

Hence we get these great ice rivers flowing down the slopes and submerging the earlier cwm glaciers, and the valleys which they have slowly eaten out. Such an overflow is suggested in the Ferrar Glacier (see Fig. 5), but is actually witnessed in the Wilson and Mackay Glaciers farther north.

The step at the head of the buried cwm gives rise to most of the crevassed areas so characteristic of many outlet glaciers (see Fig. 5). In the course of ages the edge of this step is worn away, and only a local steepness in the gradient preserves the older cwm-step. Finally the great outlet glacier dwindles and retreats, uncovering the defaced cwm erosion below. Hence the term " palimpsest " which I have suggested for this type of erosion.

Around the snout of the great glacier thawing takes place, and the nivation (thaw-and-freeze) weapon is strongly reinforced here. Hence a marked halt of the glacier is shown by the gradual erosion to base level of all the surrounding rocks. This is illustrated in the fourth type shown in Fig. 5. I believe that the Taylor Glacier retreated rapidly from the sea to the top of the first step (or riegel). Then it retreated very slowly indeed, so that nivation, supplied with water by the dying glacier, in the course of ages has nibbled the vicinity almost to base level. In this case it has cut out the basin of Lake Bonney, which extends about five miles below the present snout and reaches to the great rock-bar of the Nussbaum riegel. This latter opposes an abrupt wall 2,000 ft. high to any further advance of the Taylor Glacier, and only at the northern side is there a narrow drainage outlet, which we named the Defile. Thus the last sketch in Fig. 5 is a generalized diagram of the origin of the structures which are drawn more closely to scale in Fig. 2.

Many other problems of glacial geology awaited me in the Antarctic. Some of them I have described elsewhere,* while many more are still engaging attention. But any reader who desires to learn further of Antarctic geology cannot do better than consult the two large memoirs (recently published by Heinemann) which redound so greatly to the credit of Shackleton's First Expedition.

The following is a tentative list of the chief formations in South Victoria Land, Antarctica.

Recent	Raised beaches of MacMurdo Sound. Moraines, debris cones, and fluvio-glacial deposits. Modern Erebus Lavas.
Pleistocene ?	Basic puys of Taylor Valley and Hut Point.
Pleiocene to Present ?	Kenyte lavas of Mount Erebus.
Cretaceous	Quartz-dolerite sills of MacMurdo Sound.
Permian	Coal seams of the Beardmore (and Mt. Suess ?) Upper Beacon Sandstone.
Carboniferous	Middle Beacon Sandstone ?
Devonian	Fish Beds of Lower Beacon Sandstone (Mt. Suess).

Some of the massive granites of Ferrar Glacier and Granite Harbour probably come in here.

Cambrian	Archeo-cyathinæ limestones of Beardmore.

The schistose granite of the Ferrar coast with its included limestones and slates may also be Cambrian, but is probably older.

Pre-Cambrian	The basal schists and gneisses of the west MacMurdo Coast.

* With Scott—The Silver Lining, 1916. London : Smith, Elder & Co. *Geographical Journal*, London (Oct., Nov., Dec.), 1914

Indian Minerals in 1916.

The Records of the Indian Geological Survey show that the output of coal during 1916 was 17,254,309 tons, as compared with 17,103,932 tons in 1915.

There was a slight increase in the output of iron ore, which rose from 390,270 tons in 1915 to 411,758 tons in 1916. Of this nearly 241,000 tons was won in Mayurbhanj State and over 150,000 tons in Singhbhum. The former material was used by the Tata Iron and Steel Company and the latter by the Bengal Iron and Steel Company. These two companies produced 152,460 tons and 92,250 tons of pig-iron, respectively. The Tata Company produced 92,902 tons of steel, including rails, and the Bengal Co. 30,605 tons of iron castings.

There was an increase in the output of magnesite, which rose from 7,450 tons in 1915 to 17,640 tons in 1916.

There was an increase in the output of manganese ore, which, however, is still considerably smaller than in pre-war years. The output in 1916 aggregated 645,204 tons as against 450,416 tons in 1915, the bulk in both years being contributed by the Central Provinces. The exports during 1916 amounted to 580,328 tons, as against 418,733 tons in 1915.

There was an increase in the output of chromite the figures (20,159 tons as against 3,767 tons in 1915) being the highest yet recorded, and being only approached by those for 1907, when the output reached a total of over 18,000 tons, after which it fell rapidly to under 2,000 tons in 1910. The present recovery is due to difficulties which have interfered with the industry in New Caledonia and Rhodesia. The Baluchistan chromite, being of high grade, is in considerable demand, and a railway is now being constructed in order to make the mines more accessible. The output for 1916 in this province was more than three times that of the preceding year, and amounted to 7,620 tons. There was also a very large increase in the output from Mysore which rose from 1,041 tons in 1915 to 9,802 tons in the year under review. In Singhbhum also there was a substantial rise.

MANGANESE IN WEST AFRICA

By STANLEY H. FORD, A.R.S.M., M.Inst.M.M.

The author gives an account of the deposit of manganese ore in West Africa, discovered a few years ago, and now providing supplies for the English steel makers.

THE manganese ore deposits here described are situated at Dagwin, near Taquah, in the Gold Coast Colony. They were discovered by Mr. A. E. Kitson, the Government Geologist, in May, 1914. The main deposit is on the property of the Wassaw Exploring Syndicate, which is controlled by the Fanti Consolidated Mines, Ltd. At the southern end it extends into the Dagwin Concession and at the northern end into the Insuta Concession, owned by the Dainsoo Gold Mine, Limited (controlled by Fanti Consolidated Mines). The concession held by the Wassaw Exploring Syndicate included all minerals, but the certificate of validity of the Dagwin Concession did not cover manganese, and a manganese concession was taken up by Fanti Consolidated Mines on behalf of the owners of the Dagwin Concession, in which Fanti Consolidated Mines has $\frac{2}{5}$ths, the Gold Coast Amalgamated $\frac{2}{5}$ths, and the Gold Coast Development Syndicate $\frac{1}{5}$th interest.

The impossibility of procuring supplies of manganese ore from the Caucasus, and the difficulties in connection with the shipment of ores from India and Brazil, caused a shortage of ferro-manganese in this country and America. New sources of supply were therefore eagerly sought, and Mr. Kitson's discovery received accordingly due commercial recognition.

As manganese ore was urgently required for munitions purposes, instructions were given to start development work at once at the Dagwin deposits and to have ore shipped at the earliest possible date. Although the clearing of the dense forest, with which the country is

ORE STACKED READY FOR SHIPMENT.

Removing Overburden containing Manganese Boulders.

covered, was only commenced in June, 1916, a siding from the main railway line between Seccondee and Coomassie was built, and the first shipment of ore, 174 tons, was made early in September of that year. This quick work, for West Africa, was only possible through the existence on the spot of the organizations controlled by the Fanti Consolidated Mines, Ltd., including the staff and workshops of the Abbontiakoon Mines, Ltd., which, in the special circumstances, were requisitioned freely.

The Seccondee - Coomassie railway runs through the Dagwin Concession, and, at about 33 miles from Seccondee, ore is found at a distance of about 200 yards from the line. Massive outcrops are found on the crest of a ridge which runs north-east for about 2½ miles from the 33 mile post. A preliminary examination, with sampling at regular intervals, showed that the outcrop is practically continuous over the whole 2½ miles, and that, generally, it consists of ore with from 42% to 52 or 53% of manganese. There are, however, patches where the manganese content is so low that the material is valueless. Similar ore has also been found still farther to the north-east and half a mile inside the adjoining Insuta Concession.

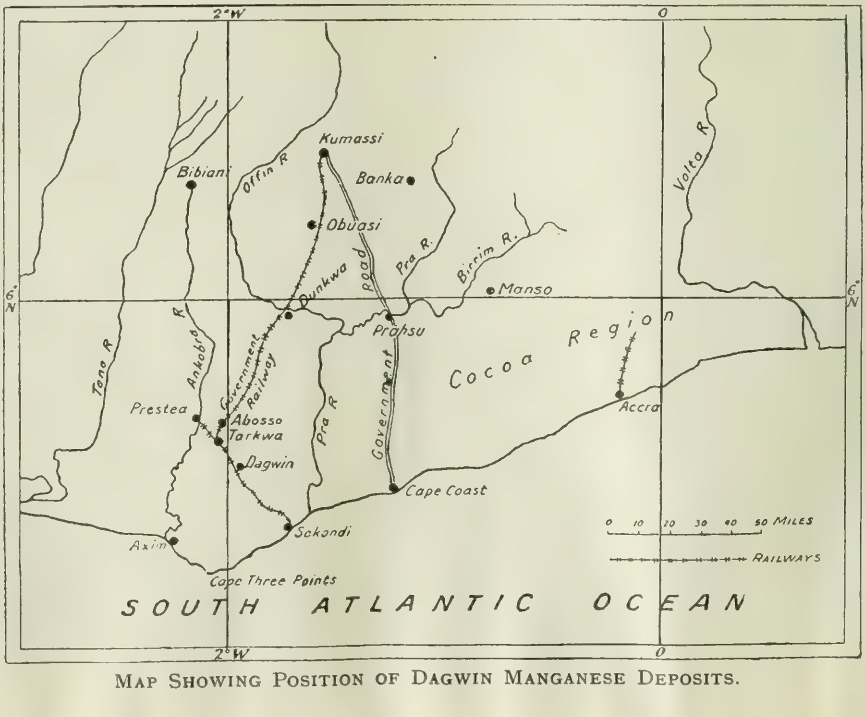
When work was started, there was hardly any labour available in the district, without drawing on the neighbouring gold mines, which were themselves short of labour. The difficulties in obtaining natives would have been very great, but that the Governor of the Colony interested himself in getting natives from the Northern Territories of the Colony, and from Togoland. The position, therefore, was that: (*1*) ore had to be produced without delay from the massive outcrops nearest the railway, (*2*) labour had to be organized for this work as natives came in, and (*3*) prospecting to find out the character and extent of the deposit had to be done after a scheme of work had been laid out, and when a few natives could be spared for the necessary clearing and trenching.

The ore shipped so far has been recovered from a detrital deposit lying on the slopes of the main ridge, which is the result of the weathering of the main outcrop on the crest. The detritus consists of boulders and nodules of ore embedded in clay, and the thickness of the surface deposit varies from 18 inches to 15 feet. The method of working is to uncover the boulders and larger fragments by pick and shovel work, along a line parallel with the length of the ridge, commencing at the lowest possible points on the slope, and working upward. The effect of this is to remove a slice from the whole of the surface of the hill slope, the thickness of the slice corresponding to the depth of the deposit. The overburden and clay, with any ore which is obviously too high in iron to ship, are thrown behind the labourers on to the lower slopes of the hill, while the embedded nodules, and the boulders, after blasting, are stacked for sampling, and assayed before being trammed to the ore-bin at the siding for despatch by rail. The question of the treatment of the clay with nodules of ore is under consideration.

One of the largest outcrops on the crest of the ridge is about 500 yards north-east of the 33 mile post; it apparently extends for about 400 ft. along the strike, with a width at right angles to this of about 70ft. An adit was put in immediately below it and from the western face of the slope, at about 220 ft. below the crest of the ridge; this adit has passed through manganese ore in three places, one of which showed solid ore for 60 ft. in the length of the adit. A main drive is being put in, in this section of the ore-body, and has been carried for a total distance of 100 ft. in solid ore, while cross-cuts from this main drive have shown the width to be maintained. The ore exposed in this adit, and its subsidiary workings, contains between 46 and 47% manganese. The adit, where it is not in ore, is in light-coloured clay or altered shales, with a dip of 60° to 70° to the south-east, with the bedding planes fairly well marked, and showing clearly the various stages of replacement of the original material by the manganese mineral.

Although occasionally pieces of pyrolusite are found, the mineral generally is psilomelane. Broadly speaking, the contents of manganese plus iron are fairly constant at 55 or 56%; thus with 53% of manganese, there is about 3% of iron; with 45% manganese, there is about 9 or 10% iron; while in clean ore the silica and phosphorus are low. Up to July 31, 20,600 tons has been shipped, with an average content of manganese 52%, iron 4·6%, silica 4%, and phosphorus 0·11%. [Note.—The total shipments to November 7, 1917, were 28,465 tons.]

Although the distance from the port is only 33½ miles, the freight charge over the Government Railway is 6s. per ton, with 1s. per ton harbour dues, and this includes no handling whatever. The handicap of this very high rate is realized when it is remembered that it is about ten times as high as the rate on the ore delivered at Bombay over the Indian Railways.



Map Showing Position of Dagwin Manganese Deposits.

THE TAYLOR CONCENTRATOR FOR TIN SLIME

By J. WARING PARTINGTON,

Chemist to East Pool & Agar, Limited.

The author gives particulars of a new table that is giving improved results in connection with the dressing of slime tin. This is the invention of Mr. M. T. Taylor, the superintendent at East Pool, Cornwall. A large part of the experimental work in connection with the machine has been in the hands of the author of this article.

AT the present time, when so much interest is being centred on the problem of increasing the extraction of the mineral contents of Cornish ores, the following description of a new departure in the design of mineral concentrating machines, recently erected at the East Pool mine, may be of some interest. This concentrator was the outcome of an endeavour to eliminate certain disadvantages inherent in the design of the usual type of revolving wooden round frame.

The faults in the design of present day machines may be summarized as follows: Low capacity for area of frame surface; non-adjustable angle of concentrating surfaces; variations in the velocity of the pulp as it flows over the surface, that is, an increase of speed, and consequently, a scouring action, as the flow reaches the inner edge of a concave round frame, and on the other hand a slowing up, and therefore, premature deposition of the larger grains of gangue near the edge of a convex frame. To what extent these defects have been overcome may be judged from a brief description of the Taylor frame in its latest form.

It consists essentially of 24 rectangular concentrating surfaces attached to, and revolving with, a central vertical shaft. The latter is provided at its upper extremity with a worm gearing, by means of which motion is imparted to the frame. On the vertical shaft is mounted a cast iron centre boss, which forms the support for 16 horizontal radial arms, constructed of L-section iron. From these arms, one edge of each surface is suspended by means of suitable adjustable hangers. The surfaces are arranged in two series. The central boss is so arranged that it is capable of being raised or lowered at will by means of a jack-screw mounted on the top end of the shaft, thus making it possible to raise or lower the radial arms and with them the edge of each surface, thereby giving a ready means of adjusting the angle of concentration to suit varying conditions of materials, etc. The free end of each surface is supported at the correct angle by means of grooved wheels mounted near the centre of each, and running on a circular rail. Two rails are provided, one for the inner and one for the outer series. These rails add considerably to the efficiency of the table, as will be shown later.

The pulp-feed and wash-water are conveyed to the surfaces through spiral stationary launders, which deliver their contents at regular intervals along their length, through small vertical down pipes, into a revolving feed launder or distributer, mounted on the arms. The bottom of this distributer is formed something like the teeth of a saw, and as the vertical edges of the teeth pass under the small delivery pipes, the pulp or water flows down the slope forming the back of the teeth and so through an opening in the side of the distributer, on to the feeder of the surface, by which it is spread in an even film over the whole area. The teeth, or stops, in the distributer, are spaced at equal distances round the circle, there being a stop for each surface. The distributer is divided down its centre into two compartments, one supplying the outer series and the other the inner series.

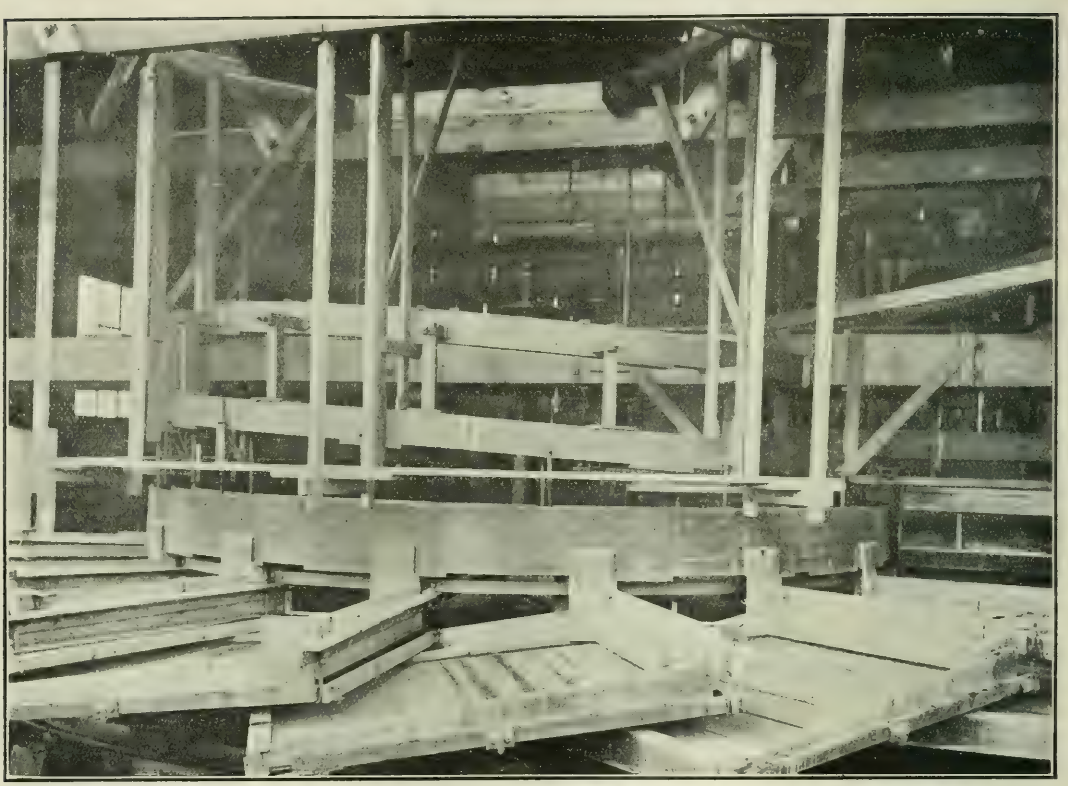
It is possible to continue the pulp-feed for any desired portion of the revolution by cutting off the supply to one or more of the small feed pipes by means of stoppers in the spiral launder. The cleansing water may be regulated in like manner.

For some time it had been suspected that a certain amount of classification took place in the feed launder of a round frame, so tests were made, and results obtained as follows. A sample, No. 1, was taken of the feed to a wooden concave round frame 1 ft. from where it first entered the circular feed launder, and another sample (No. 2) was taken from the same launder 2 ft. from where the cleansing water started. These samples were graded with the results in the table below.

	No. 1. % weight.		No. 2. % weight.	
Plus 60	0·9	22·9% plus 200	0·6	4·6% plus 200
,, 120	7·7		0·5	
,, 150	5·0		1·7	
,, 200	9·3		1·8	
Minus 200 A.	34·1		27·6	
,, 200 B.	43·0		67·8	

Minus 200 A was the slime which settled out after 30 seconds standing, and minus 200 B was that portion which remained in suspension.

From the above results it will be seen that



THE TAYLOR CONCENTRATOR FOR TIN SLIME.

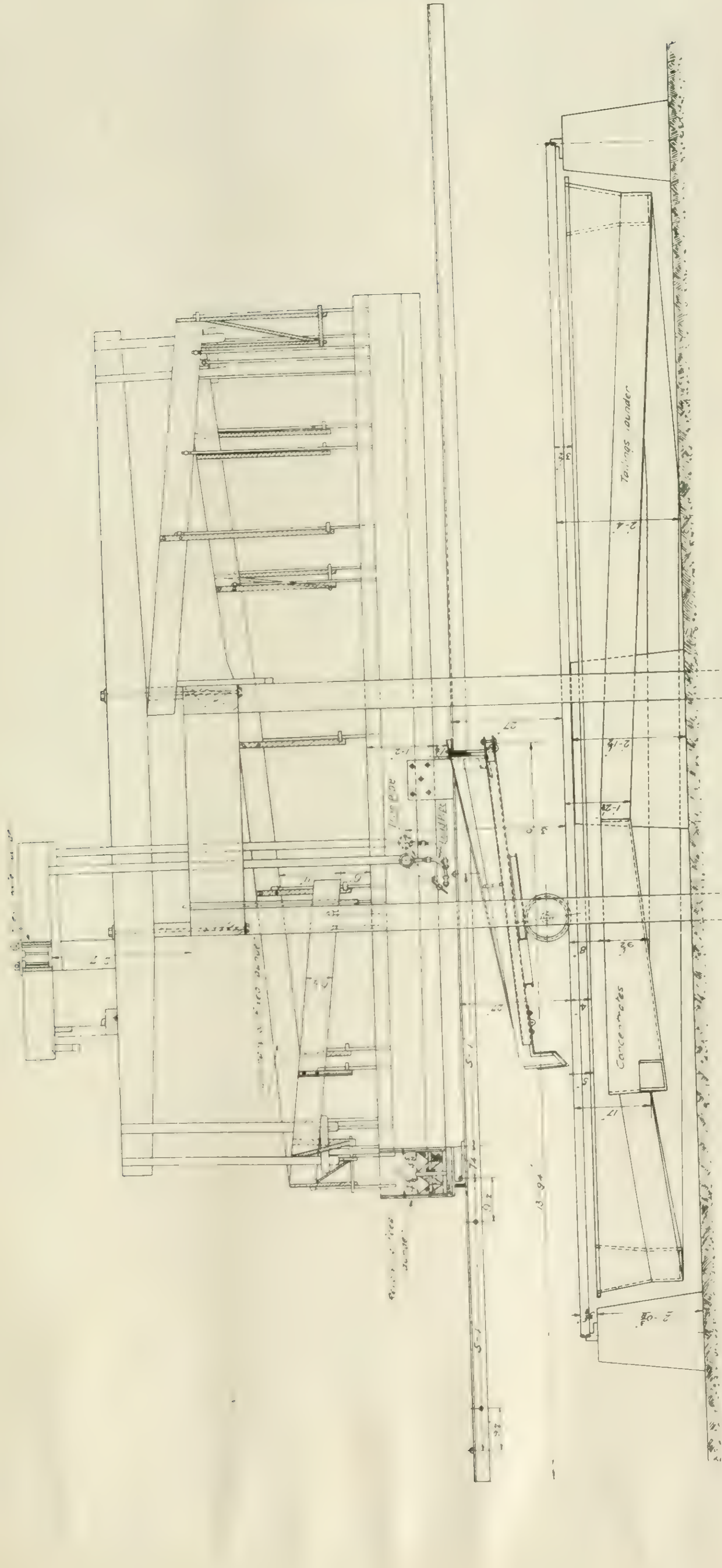
considerable classification does take place in the feed launder, there being 22·9% of plus 200 near the commencement of the feed and only 4·6% near the end. Advantage of this fact is taken in the Taylor frame, by placing small baffles across the spiral feed launder just behind each down pipe. By this means the coarser product which travels along the bottom is deflected down the first pipe, and so the next pipe receives the next finer product, and so on right round, so that the last surface treats the finest material of all.

In order to show the efficiency of this rough launder classification two more samples were taken from the spiral feed launder. No. 1 sample was the material fed through the first down pipe and No. 2 was that fed through the last one.

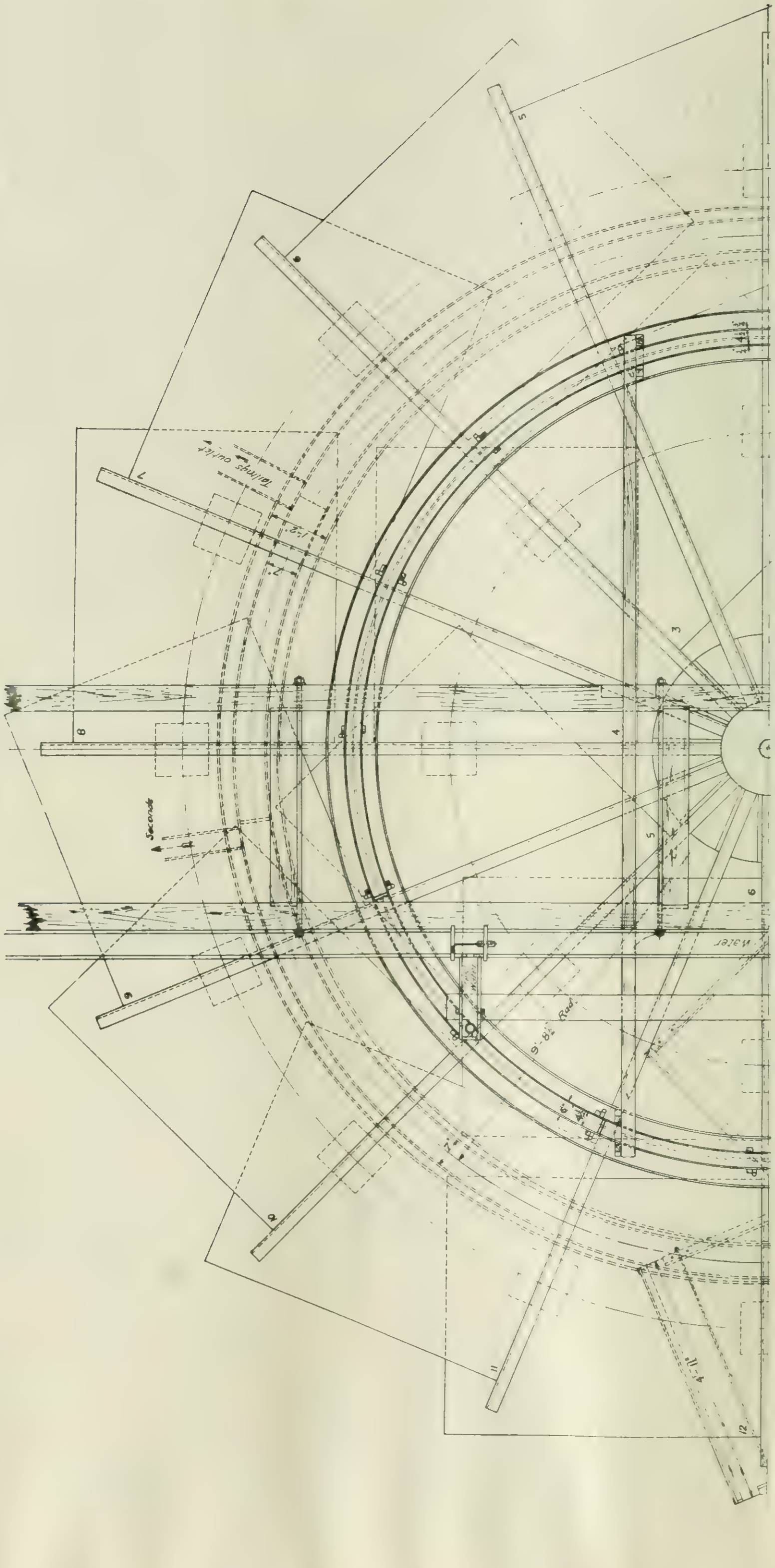
No. 1.	% weight.		No. 2.	% weight	
Plus 60	4·6	12·0% plus 200	Plus 60	0·40	1·38% plus 200
,, 120	3·4		,, 120	0·52	
,, 150	2·0		,, 150	0·64	
,, 200	2·0		200	0·32	
Minus 200 A.	14·4		Minus 200 A.	9·20	
,, 200 B.	73·6		,, 200 B.	88·92	

These results were very fair, so in order that each product, as it flows in turn over the surfaces, shall have the most suitable angle for concentrating, the rails on which the planes are supported are set at a slightly upward gradient for a portion of the revolution, thereby lessening the slope of the surfaces as they travel round. Thus the angle is greatest while the coarser material is being fed on, and least where the fines are being treated. During the period of cleansing, the rail remains level, and when the point is reached at which the concentrate is to be washed off, the rail dips slightly and so comes to the correct angle for the coarse feed again.

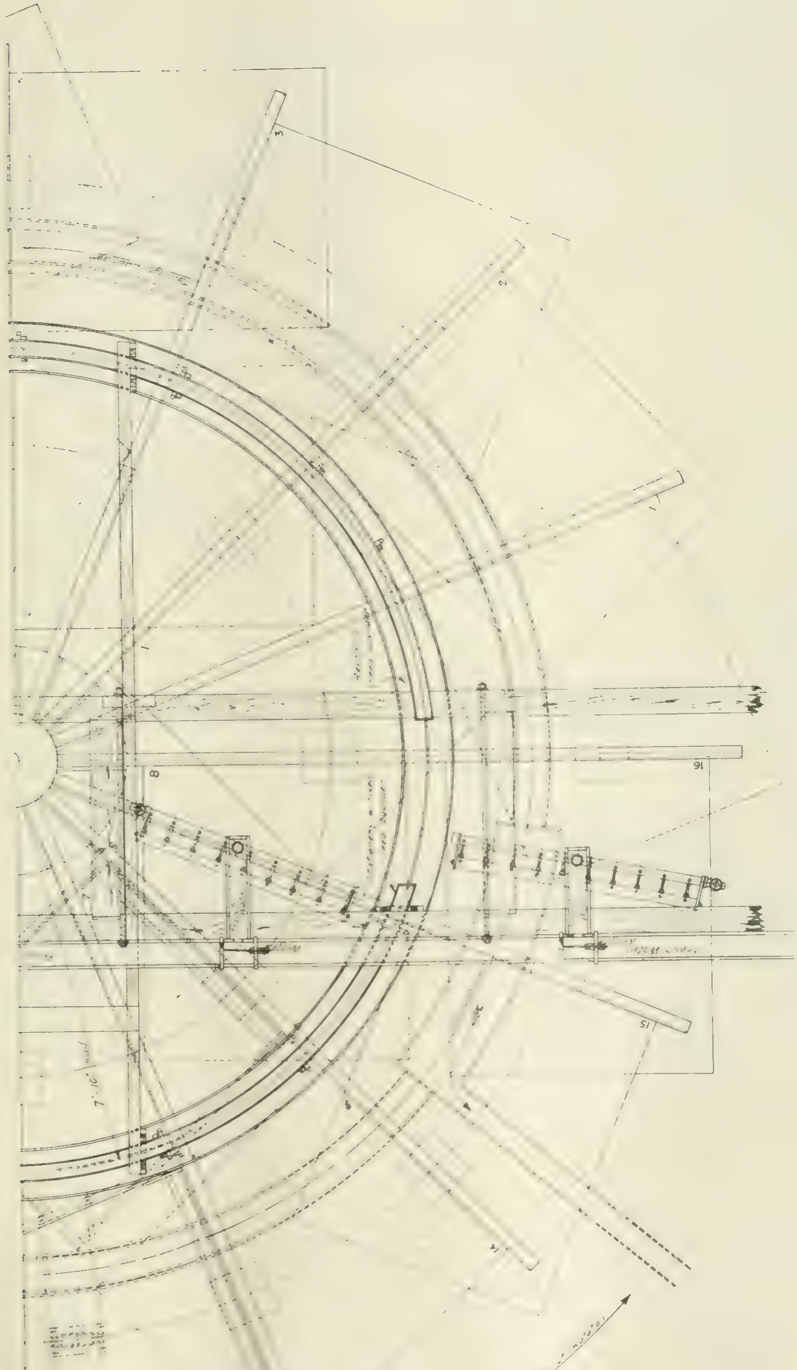
At first a little difficulty was experienced in washing the concentrate off the planes. Various means were tried with indifferent results. The present method was devised by the author, and consists of ten $\frac{3}{16}$ inch jets mounted on short lengths of lead piping, thereby making the individual angle of each jet adjustable. These lead pipes are in turn mounted on a suitable iron pipe set at right angles to the frame. The jets are supplied with water under a head of 10 ft., and impinge horizontally on the edge of an iron plate set at a suitable angle. The jets then resolve them-



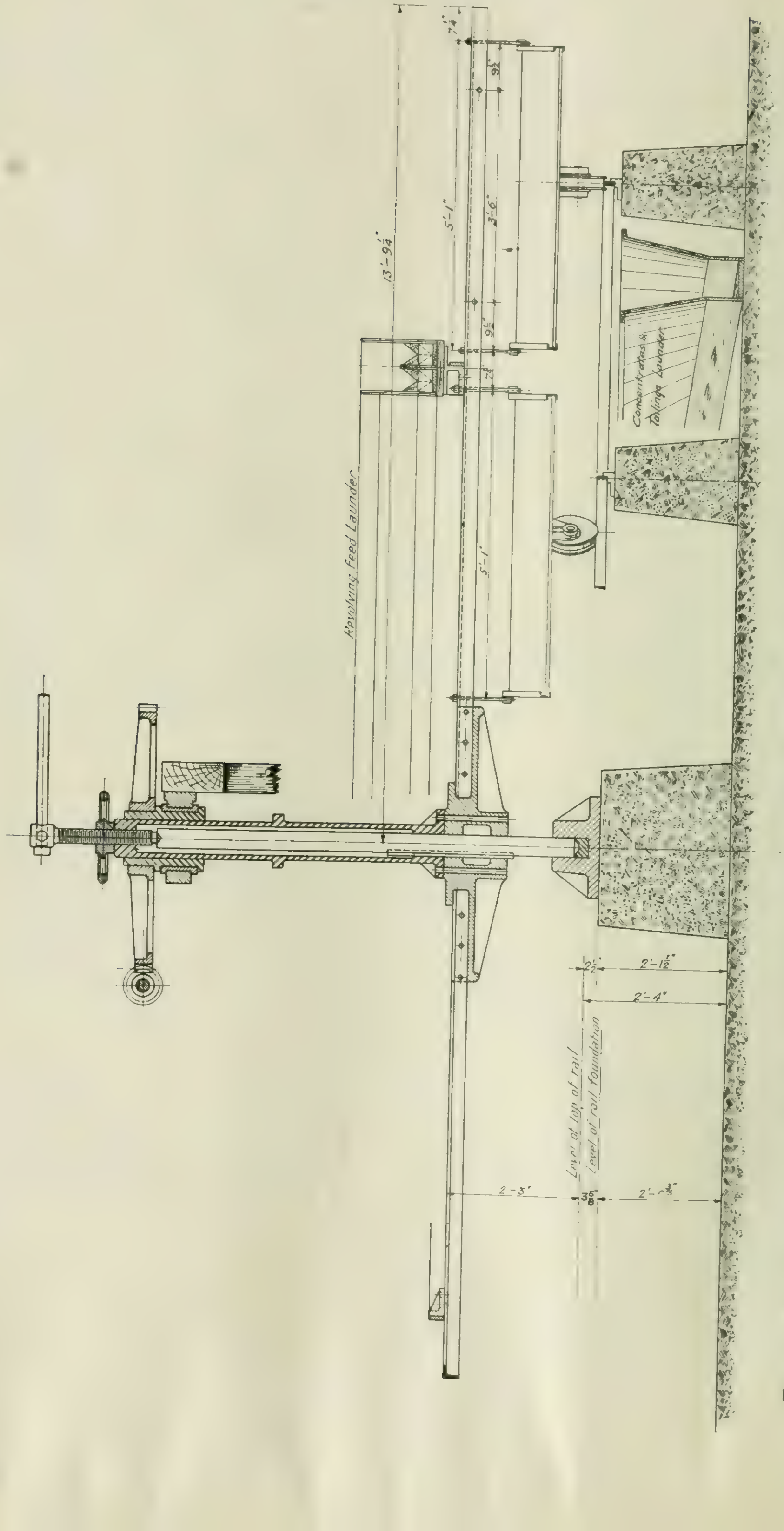
Elevation of the Taylor Concentrator for Tin Slime.



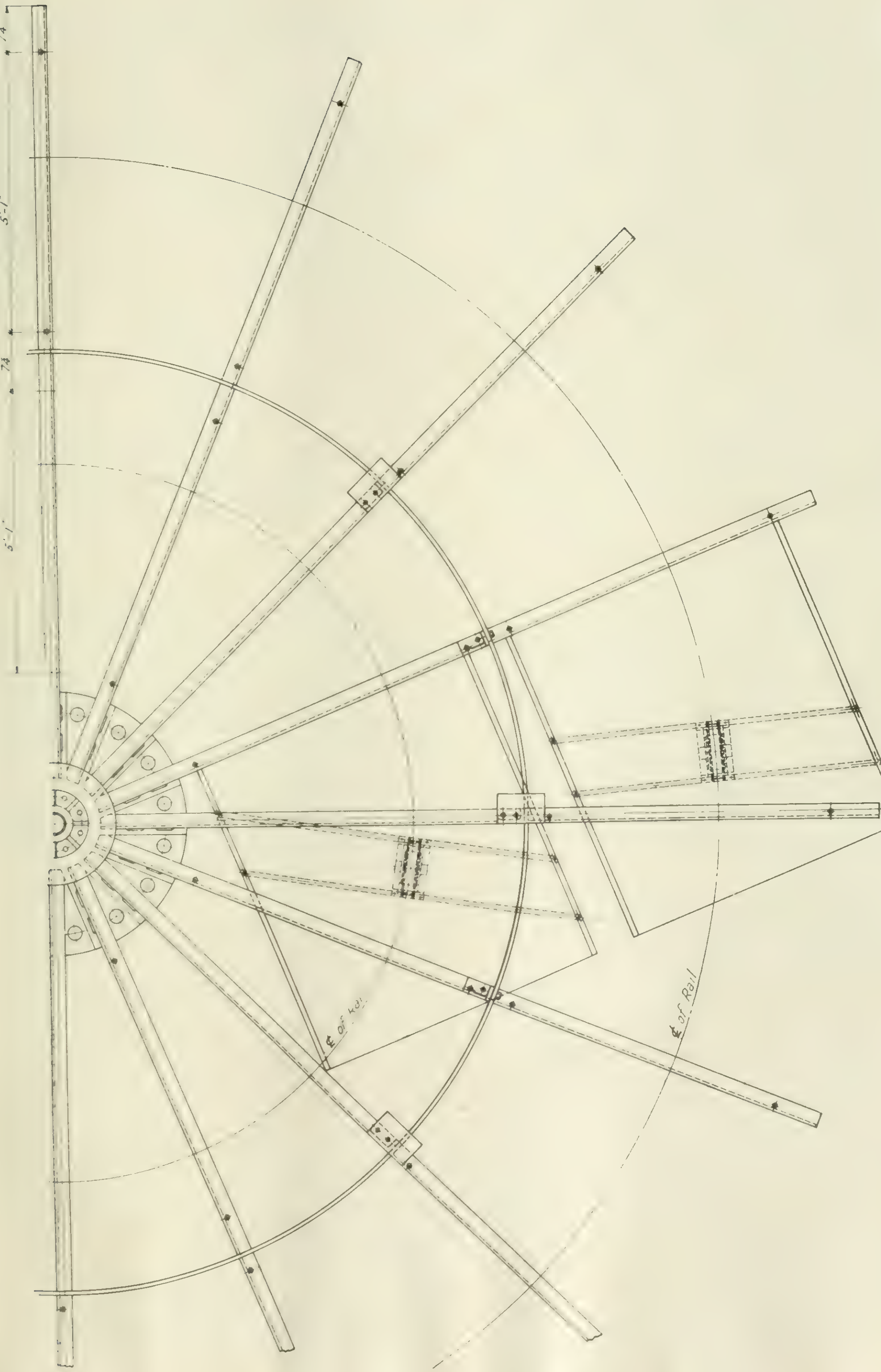
Plan of the Taylor Concentrator for Tin Slime
(continued on the opposite page).



PLAN OF THE TAYLOR CONCENTRATOR FOR TIN SLIME
(continued from the opposite page).



THE TAYLOR CONCENTRATOR FOR TIN SLIME. VERTICAL SECTION SHOWING THE POSITION OF THE CONCENTRATING SURFACES AND THE FEED LAUNDER.



THE TAYLOR CONCENTRATOR FOR TIN SLIME. PLAN SHOWING THE METHOD OF ATTACHING AND SUPPORTING THE CONCENTRATING SURFACES.

selves into 10 fan-like sprays, which spread in an unbroken line right across the surface and effectually clear off the heaviest concentrate with considerable saving in water. The sprays are stationary, and there is of course one for each series of frames.

Lubrication of the working parts of the table is made easy and effective by means of screw grease cups, placed in suitable positions and easily got at while in motion. There are no delicate parts to get out of order, and although at first sight the accompanying drawings may seem very complicated, such is not really the case.

The full capacity of the frame consistent with good work, will, of course, depend on the initial value of the material treated; but, in the light of numerous tests made on an unburnt slime averaging 11 lb. metallic tin per ton, the tonnage treated varied from 15 to 25 tons per 24 hours. The capacity was reckoned at about 8 times that of an ordinary round frame.

Appended are three average tests of 6 hours, 5 hours, and 3 hours duration, respectively.

TESTS OF ORE.

	6 hr. Test.	5 hr. Test.	3 hr. Test.
Tons of feed	20	25	20
Assay-value of ditto (lb. per ton)	11·1	10·6	12
Total Sn in feed (lb.)	220	265	240
Tons of middles	3	5	3·5
Assay-value of ditto (lb. per ton)	7	10	7·5
Total Sn in middles (lb.)	21	50	26·2
Tons of tails	14	16	13
Assay-value of ditto (lb. per ton)	6	5·5	5·5
Total Sn in tails (lb.)	88	88	71·5
Tons of concentrates	3	4	3·5
Assay value of ditto (lb. per ton)	35	33	35
Total Sn in concentrates (lb.)	115	132	122·5
Total Sn in feed (lb.)	220	265	240
Total Sn recovered (lb.)	115	120	122·5
Percentage extraction of Sn as concentrate	52·3	50·5	51·0
Cash value of feed per ton (with Sn at 1s. per lb.)	11s. 1d.	10s.	12s.
Cash value of concentrate obtained from 1 ton of feed	5s. 7d.	5s. 3d.	6s. 2d.

In conclusion it may be said that although the accompanying results only show the extraction of the tin contents, a considerable improvement was also observed in the recovery of other valuable minerals, particularly wolfram and arsenic.

The Nitric Acid Problem.

The Minister of Munitions has issued a circular relating to the production of nitric acid, and the work done by the Nitrogen Products Committee of the Munitions Invention Department. A few extracts are given herewith. When the war began, the Central Powers, by extending their established nitrogen fixation processes and by developing others such as the cyanamide process for the production of nitrolim or ammonia, and the oxidation process for converting ammonia into nitric acid, became self-sustaining. Although the command of the seas enabled us to import from Chile all the nitrate of soda we needed for munitions and agriculture, and so escape the consequence of our scientific neglect, the beginning of the submarine campaign, in February, 1916, forced us to review the position. In June, the Nitrogen Products Committee was set up under the chairmanship of the Comptroller of the Munitions Inventions Department of the Ministry. Before the Committee lay the difficult task not only of discovering the working details of some of the more important processes, which are carefully guarded by the foreign firms who are working them, but of making the processes commercially practicable. Because of the pre-eminent position held by the Haber process in Germany, where the economic conditions as regards coal supplies and the comparative absence of water power are similar to those here, and because it was plain that the research would be especially difficult owing to our limited knowledge of the process, attention was first directed to the problem of the production of synthetic ammonia. The Committee then turned its energies to bringing to a commercial stage the ammonia oxidation process for producing nitric acid from gasworks and other forms of ammonia, a process which had not hitherto been practised in England, although worked to some extent on the Continent. Manufacturers interested in ammonia oxidation met the Comptroller, with the outcome that in several of our largest chemical works the process is being introduced to take the place of the nitre-pots used in the making of sulphuric acid by the chamber method.

The investigation of the Haber process has involved the solution of several difficult chemical engineering problems, as was to be anticipated in operations necessitating the compression and manipulation of gases at extremely high pressures. The whole of the conditions governing the process have been thoroughly studied, with the result that a method of working has been devised whereby the output of ammonia per unit of plant has been increased to a figure which, as far as is known, has never been approached, even in Germany, the home of the process. A semi-technical Haber unit is now in operation, and is providing data concerning the few further details to be elucidated before they proceeded with the erection of a full-sized unit.

EAST POOL DRESSING PRACTICE.

We give herewith a description of the present dressing practice at the East Pool & Agar tin-wolfram-arsenic mine, at Camborne, Cornwall. The flow-sheet will be found on a folder inserted to face the succeeding page.

IN this issue we present a flow-sheet of the dressing practice at the East Pool and Agar mines, in Cornwall. This flow-sheet is printed on a folder inserted opposite this page. We have to thank Mr. M. T. Taylor, the manager, for giving us this complete account of a plant which admirably reflects the present practice in the dressing of Cornish tin-wolfram-arsenic ores. In our editorial on Professor Truscott's investigations and recommendations relating to tin concentration we refer to his desire to simplify the practice and to reduce the almost interminable series of treatments and re-treatments. Professor Truscott's arguments may be more readily appreciated by reference to this specific flow-sheet representing actual practice. We have said in our editorial that, despite much criticism from outside, Cornish practice for fine tin ores still stands. Engineers from other countries, such as Mr. Taylor and Mr. Arthur Richards, have not attempted to revolutionize the system, and other outsiders who have worked hard for the purpose of improving and simplifying the methods have attained little or no result. Before starting to trace the course of the ore through the flow-sheet we may mention that the Taylor table described in another article in this issue has been used on the tailing from No. 1 slime plant. Also that in the flow-sheet and in these notes the reference is to tin content, figures for arsenic and wolfram being given only for the final products.

The average amount of ore going to the stamps per day is 230 tons, and the average assay-value 25 lb. of metallic tin per ton. The pulp from the stamps is sent to hydraulic classifiers, where it is divided into coarse underflow (173 tons, 26 lb. Sn) which goes to 22 Wilfley tables, and slime overflow (57 tons, 23 lb. Sn) which goes to No. 1 slime plant consisting of 60 rag or "rack" frames. The produce from the Wilfleys is: (1) 10 tons of concentrate averaging 12% Sn, which is sent to the roasting (called "calcining") plant; (2) 60 tons of middling averaging 15 lb. Sn which is re-ground in tube-mills and sent to 20 Frue vanners; and (3) 100 tons of tailing averaging 4 lb. Sn. The tube-mills that treat the middling also treat returned oversize (10 tons, 7½ lb. Sn) from the Frue vanner tailing, and a tail product (10 tons, 28 lb. Sn) from the coarse calcined ore section to be mentioned later. The vanners treat 80 tons per day averaging 25 lb. Sn. From this is produced 6 tons of concentrate averaging 13% Sn, which goes to the calciners, and 74 tons of tailing averaging 8 lb. Sn. This tailing is classified, and the coarser portion is sent back to the tube-mills as already mentioned. The overflow (64 tons, 9 lb. Sn) goes to No. 2 slime plant, which consists of 60 rack frames. These rack frames produce a head averaging 12 lb. Sn, and a tailing averaging 7 lb. Sn. The head is passed over round frames, which produce a head averaging 30 lb. Sn and a tailing averaging 7 lb. Sn. Subsequently buddling obtains a final head averaging 4·5% Sn which goes to the calciners. The tailings (total 72 tons) from the rack frames and round frames in No. 2 slime plant go to No. 3 slime plant, together with tailing from No. 1 slime plant (54 tons), and 16 tons from the slime and coarse sections of the calcined ore concentrators, to be mentioned later. Here it should be interpolated that the rack frames in No. 1 slime plant produce a head averaging 28 lb. Sn and a tailing averaging 15 lb. Sn. The head is treated in 7 round frames producing a head averaging 60 lb. Sn and a tailing averaging 20 lb. Sn. The head from the round frames is treated on a dumb buddle until a concentrate averaging 6% Sn is obtained which is sent to the calciners.

No. 3 slime plant consisting of 70 rack frames treats 142 tons averaging 12 lb. Sn per day, producing a head averaging 16 lb. Sn and a tail averaging 7 lb. Sn. The head is treated on frames, from which the head averaging 24 lb. Sn goes to buddles, on which it is treated over and over again until a concentrate averaging 3% tin is obtained suitable for the calciners. The total final tailing from Nos. 1 and 3 slime plants amounts to 225 tons and the average content is 6·8 lb. Sn. This represents the loss in dressing in the concentration before calcining.

There are two sets of Brunton calcining furnaces, four being used for treating the coarse concentrates from the Wilfleys and Frue vanners (15 tons averaging 11·7% Sn), and two for the slime concentrates coming from Nos. 1, 2, and 3 slime plants (total 6 tons, averaging 6, 4½, and 3% respectively). The arsenic recovered amounts to 1 ton per day.

The calcined slime goes to classifiers. The spigot discharge, averaging 5% Sn, is treated on a James sand table, and the overflow, averaging 3·5% Sn, on five James slime tables. The head obtained on the sand table averages 20% Sn, and it is sent to No. 2 buddle in the coarse section of the calcined ore plant, to be mentioned later. The tailing, averaging 2%, is re-ground in tube-mills and returned to the classifier in front of the sand table. The slime tables yield three products: (1) a head averaging 18% Sn, which is buddled and kieved up to 40% Sn, the amount of final concentrate being ½ ton; (2) a middling averaging 4% Sn, which is returned to the classifier in front of the sand table; and (3) a tailing averaging 2·5% Sn. This tailing is treated on a round frame with the production of a head averaging 4% Sn, and a tailing averaging 2% Sn. The head goes to the 24 ft. round buddle in the coarse section, as mentioned later, and the tail is treated on two round tables in succession, the heads, averaging 4% Sn and 3% Sn respectively, going to the 24 ft. round frame, and the tailing to No. 3 slime plant in the primary section.

In the coarse section of the calcined ore plant, the burnt concentrate, averaging 16% Sn, goes to No. 1 buddle. The head averaging 28% Sn goes to No. 2 buddle, the middling averaging 18% is re-treated, and the tailing averaging 6% Sn is ground in 4 Holman grinding pans along with many other tailings enumerated later. No. 2 buddle treats also the head from the James sand table. It produces a head averaging 38%, which is kieved to 50% Sn and 12% WO_3. The middling is re-treated and the tailing averaging 8% Sn goes to the grinding pans. The material coming from the grinding pans is classified in hydraulic classifiers. The spigot product averaging 8% Sn goes to a James sand table, and the overflow to another classifier, from which the spigot product (6% Sn) goes to four Wilfleys and the overflow (4% Sn) goes to two round frames. The head from the James sand table averages 40% Sn and 10% WO_3; the middling (13% Sn) is treated by a series of buddles and kieves and a rich product obtained; the tailings from the sand table and the various buddles go to the grinding pans.

The four Wilfleys mentioned above yield a head averaging 10% Sn, which is re-buddled several times to get a final product, while the various tailings go back to the grinding pans. The tailing from the Wilfleys is re-ground in a small tube-mill and treated on a Wilfley and a vanner, the heads from which go to be re-buddled and the tailing goes to No. 3 slime plant. The overflow from the classifier in front of the four Wilfleys goes to two round frames. The head produced in these frames is treated, together with the head from No. 1 round frame below the James slime tables in the slime section of the calcined ore plant, and the head produced (8% Sn) is buddled until an enriched product is obtained, while the tailing is treated on round frames. From the second of these round frames, the head averaging 3% Sn goes back to the James plant, while the tail (30 lb. Sn) goes to No. 3 slime plant.

The various final concentrates, namely, those from the James slime tables, the No. 2 buddle, the James sand table and the buddles below, the four Wilfleys and the one Wilfley and vanner and the buddles below, and from the 24 ft. round frame, all go to be dried, and are then sent to the Wetherill magnetic separators. The amount treated here amounts to 84 cwt. per day, and averages 48% tin, together with wolfram, and iron. There are here recovered 60 cwt. of tin concentrate averaging 66% Sn and 2% WO_3, and 19 cwt. of wolfram concentrate averaging 38% WO_3 and 16% Sn, together with 5 cwt. of an iron product averaging 14% Sn and 5·5% WO_3, which is re-treated. The tin concentrate is kieved, and 37·2 cwt. of final concentrate obtained, averaging 68% Sn and 1·5% WO_3. The remaining tin material and the wolfram concentrate are pickled by the process described in the issue of the Magazine for June, 1915, and the product then obtained is re treated magnetically for wolfram, the yield being 6 cwt. averaging 68% WO_3, together with some tin concentrate.

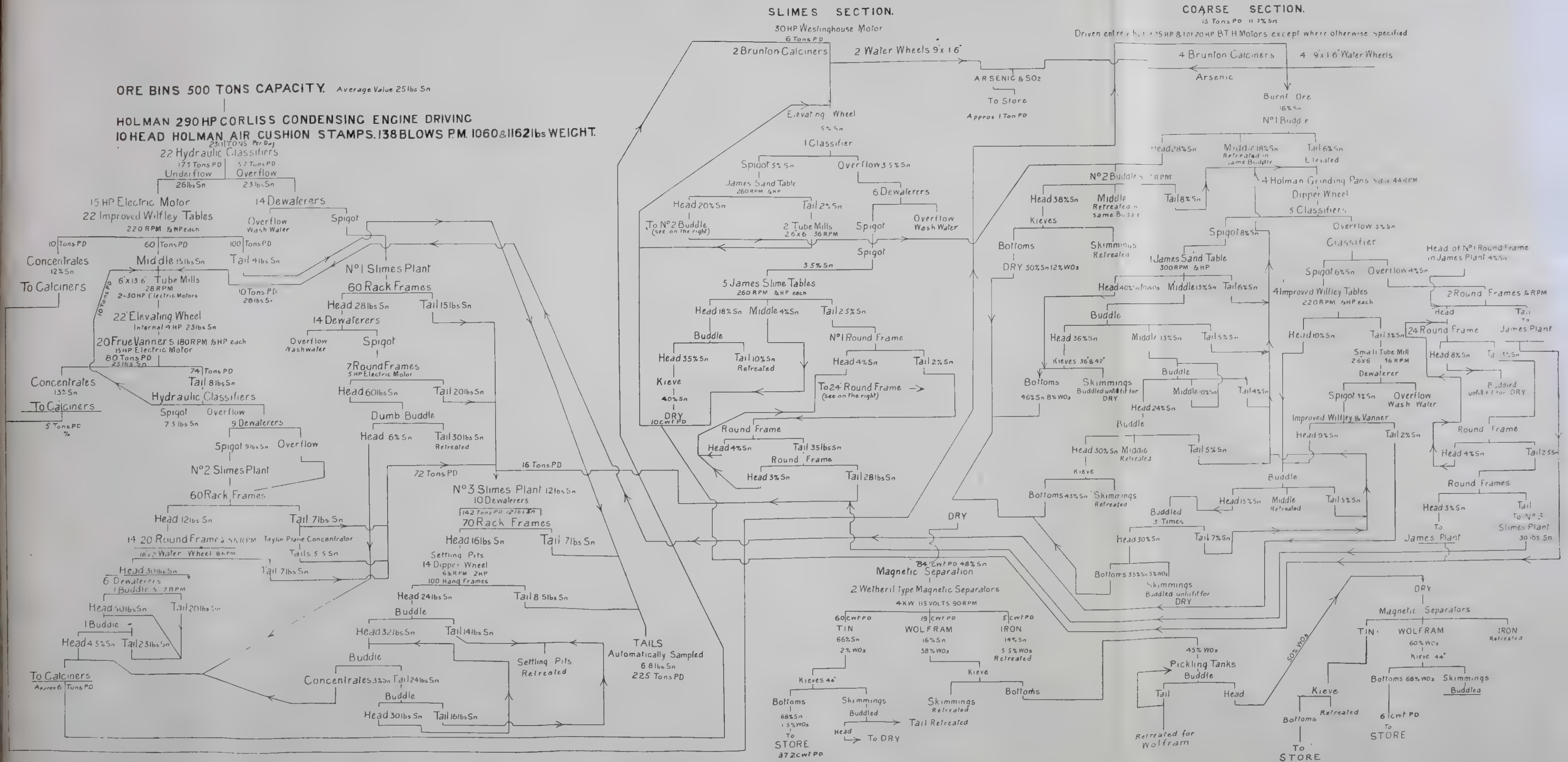
Chrome Ore in Alaska. — Mr. W. P. Lass gives an account, in the *Mining and Scientific Press* for November 3, of chrome ore deposits now being worked at Red Mountain, on the Kenai Peninsula, Alaska. These have been known for some years, but, though they are situated on the coast, they were never exploited until recently owing to the uncertain state of the market. The demand for chromium for both steel and non-ferrous alloys now offers inducement for their development. About 1,000 tons of ore averaging 46 to 49% Cr_2O_3 was shipped during the past summer. Another 1,000 tons remains to be mined above the high-water mark, and between high and low water there are also extensive resources. The mining of the deposit below water line will not be an easy problem. The ore is sent to Seattle, whence it goes by rail to the eastern states. The cost of transport is $3·50 per ton by sea to Seattle, and $12 per ton thence across the continent by rail.

THE EAST POOL FLOW-SHEET

[*Supplement to* THE MINING MAGAZINE, *December, 1917*]

PRIMARY CONCENTRATING PLANT.

CALCINED ORE PLANT.



LETTERS TO THE EDITOR

Laterite.

The Editor :

Sir—Mr. J. Morrow Campbell, in his interesting article on laterite in your August issue, discusses on page 70 the occurrence of carbon dioxide in tropical vadose waters, and says : " Sink a shaft to water-level near a tropical stream and another in a similar situation, say in England, cover them over for a few days, then test the air with a lighted candle. In the tropics the candle will be extinguished, whereas in England it will not be. In this way it is readily proved that vadose water in the tropics contains much more carbonic acid than in cooler regions."

Admitting Mr. Campbell's facts, and admitting his conclusion, his proof seems entirely fallacious. The candle test as thus carried out is, I submit, no proof of the presence of carbon dioxide, and is merely a piece of indirect evidence ; a positive reaction with lime-water or baryta would be conclusive, but even this ought to be made quantitative. Extinction of a candle-flame is equally likely, and I think under the circumstances more likely, to be due to de-oxidation of the air by pyrite or ferrous compounds in the adjacent rocks, and this effect would also be favoured by tropical heat. Examination of numerous samples of mine air has shown that the extinction of flame is in many cases caused by deficiency of oxygen rather than, or in addition to, the presence of carbon dioxide. Even when the latter is present it is in some cases generated by the reaction of limestone with the oxidation products of pyrite. These conditions have been discussed by Dr. J. S. Haldane, in his book " Investigation of Mine Air," pp. 124-132, but these do not appear to be generally recognized, though the connection of noxious air with sulphuretted or "aluminous" rock was noted by Pliny and Agricola.

Most, if not all, cases of the supposed "evolution of pure nitrogen" from rocks in metal-mining districts, which are reported from time to time, are explicable by the action of the disseminated pyrite generally present. In blue shales and clays this action is sometimes very rapid. Considering the wide distribution of pyrite and allied minerals in mining districts, and in ferruginous rocks elsewhere, it would seem that sulphuric acid and sulphates deserve a little consideration by Mr. Morrow Campbell as possible auxiliaries in the process of laterization.

W. J. SHARWOOD.

Homestake Mine, South Dakota,
September 30.

NEWS LETTERS.

CAMBORNE.

SCIENTIFIC RESEARCH.—Through the agency of the Cornish Chamber of Mines, but mainly by the efforts of Mr. Oliver Wethered, a sum of £2,500 per annum for three years has been guaranteed by the mining companies and mineral owners of the West of England for experimental researches into tin and wolfram losses upon scientific principles and under the continuous supervision of leading professional men. A similar sum will be provided by the Committee of the Privy Council for Scientific and Industrial Research, so that altogether a sum of £15,000 will be available. It is by no means an extravagant figure for the work to be undertaken, seeing that chemical, as well as mechanical, processes are to be investigated. As any improved extraction will be world-wide in its application, the companies operating tin lodes in other parts of the British Empire might reasonably be asked and expected to support this research fund. The administration of the fund will be in the hands of the Committee of the Privy Council, but aided, it is hoped, by Sir Lionel Phillips, who initiated the scheme, and two representatives of the industry nominated by the Cornish Chamber of Mines.

The Cornish Chamber of Mines has also under consideration the question of inviting the Government to offer a large reward to anyone who can evolve a process which will save, say, 75% of the loss now made in tin-dressing.

The statement was made in the report of the Privy Council issued two or three months ago that, as the result of research work by the Tin and Tungsten Committee, a method had been successfully tested which would result in a saving of a further 5% of tin, and it was estimated that if generally adopted in the West of England, the result would be an extra saving of tin to the value of £30,000. It has now been stated that this improvement is to be expected if the fluted surfacing is substituted for the existing smooth surfacing of frames. This has already been tried on a commercial scale in Cornwall, and was not a success, and anyhow it can only—if what is claimed is upheld outside the laboratory—save 5% of the slime, which will certainly not amount to the sum named. It is to be hoped that the new Research Committee will not waste time and money investigating methods which have already been tried in Cornwall and found wanting; they should tackle the problem on new lines.

WAGES.—It is now suggested by the Workers' Union that there should be a conference of representatives of the mines and of the Union to discuss the demand for increased wages as set out in my last letter. While such a conference could do no harm, the question of increased wages is clearly a matter which must be handled by each company separately, as the circumstances often vary materially. Some companies are not in the position financially to make advances on the scale demanded, much as they may desire to do so. Levant is a case in point. Here the secretary of the Union was invited to inspect the books, and he was faced with the fact that at this mine during the past 20 months, wages to the value of £43,000 had been paid, but the shareholders had had only £625 in dividends, or about 2½% on the present price of the shares. It was obvious that no general advance could be made under present conditions, unless it was secured by increased efficiency. The Union representative suggested that an effort should be made to get the payment of mineral royalties abolished. As the Crown is largely interested, the suggestion is not likely to be welcomed at the Treasury, but the management committee has made the sporting promise to allocate any concession in this direction to the employees.

At Geevor, in the same district, a settlement has been arrived at by which contract men will be paid a minimum wage of £2 per week on condition that a minimum of 23 shifts of 8 hours each per four weeks shall be worked, and that no man shall cancel his contract during the period it is in existence. The men have also to be at work within 15 minutes of leaving the top of the shaft, and shall not leave the working face until 15 minutes of the time they are due at surface. If one could be sure that the men would work all the time (excluding "croust") they are at the face, this settlement might be regarded as reasonably satisfactory, but experience teaches that, particularly in the larger mines where the working places are often far apart, and supervision is necessarily perfunctory, it is seldom that men on day-pay work more than 5 to 6 hours at the face on an 8-hour shift.

GEEVOR TIN MINES.—The belated report and accounts of this company for the 15 months ended December 31, 1916, have recently been issued. For this period it appears that 28,683 tons of ore was milled, producing 444 tons of tin oxide, equivalent to a recovery of 34·69 lb. per ton. The average operating cost at the mine was 33s. 8d. per ton, while administration charges figure at a further 1s. per ton. The gross profit earned amounted to £7,878, but debenture interest, depreciation on shaft-sinking and development, etc., absorbed £4,878, leaving £3,000 to be carried to the balance sheet. The chairman reported that the last fortnight's sale was valued at £2,300, so that approximately the production is now 12 tons of black tin per fortnight. The main shaft is down to a depth of 789 ft. and the stations are being cut; when these have been completed a sump will be made and the shaft timbered to the bottom. If the proposed seventh level at this depth on the Pig Lodes discloses ore-bodies of a similar length to those found in the levels above, then the manager, Mr. W. C. Williams, estimates this new level will provide approximately 135,000 tons of ore. The vital point, of course, is the value of such ore-bodies, and this only development will prove. A cross-cut is being driven at the fifth level to intersect the north lode, supposed to be the Levant main lode, which was located by the diamond-drill recently, and is of considerable prospective value, for the core of the drill was of a very satisfactory character. This lode is otherwise untouched in the Geevor sett. It is proposed to increase the milling capacity, although it would appear that, owing to labour difficulties, the existing mill has only worked 75% to 80% of its capacity. Presumably these additions are in anticipation of the time when the men now on unproductive development work will be available for stoping, with a consequent increase in tonnage. It is evident from the report that the developments on this property are proving eminently satisfactory, and that those who have subscribed the money spent on it, are likely soon to receive interest on their capital.

PERSONAL.

LAWRENCE ADDICKS has gone from New York to Burma to study the metallurgical problems at the Bawdwin mines.

R. S. ARCHBOLD has returned from Siberia.

L. D. CAMERON, who was in charge of the Rayfield properties during the absence of J. M. Iles, has arrived from Nigeria. He was a passenger on the ill-fated "Apapa."

G. W. CAMPION, manager of the Taquah mine, is on his way back to West Africa.

PROFESSOR H. C. H. CARPENTER is delivering a course of Cantor Lectures before the Royal Society of Arts on Progress in the Metallurgy of Copper.

W. R. FELDTMANN has returned from his annual visit to West Africa. He travelled on the "Apapa," and had a narrow escape of his life after leaving the torpedoed liner.

PHILIP L. FOSTER, representative of the Exploration Company in the United States, has been appointed captain in the Signal Corps of the United States army.

PROFESSOR WILLIAM FRECHEVILLE is to deliver a lecture before the Royal Society of Arts in the New Year on the Development of the Mineral Resources of the Empire.

C. S. HERZIG was married on October 13 to Miss Florence Upmeyer and will make his home in Salt Lake City.

C. BARING HORWOOD has been awarded the degree of D.Sc. in the London University.

J. P. HUTCHINS has returned from Petrograd.

C. E. JOBLING, manager of the Abosso mine, is here from West Africa.

E. K. JUDD has been appointed editor of the Bulletin of the American Institute of Mining Engineers.

DR. J. E. MARR has been appointed Woodwardian Professor of Geology in the University of Cambridge, in succession to the late T. McK. Hughes.

JOHN MCCOMBIE has been appointed manager of the Waihi Extended, New Zealand, and is conducting exploration at depth.

A. H. P. MOLINE has resigned as manager of the Cock's Pioneer tin and gold mines, and is now on the staff of the Bendigo Amalgamated Goldfields.

J. W. MOULE has been appointed metallurgist at the Great Cobar smelter, New South Wales.

O. B. PERRY, formerly manager of the Yukon Gold Co., is directing the formation of a mining company for the American army in France.

A. M. REID has been appointed Assistant Geologist on the Tasmanian Geological Survey.

LOUIS D. RICKETTS is taking charge of the operations at the Calumet & Arizona Mining Company during the absence of John C. Greenway on military service.

MAJOR R. W. SCHUMACHER, of the Central Mining-Rand Mines group, has changed his name to Ffennell, his mother's maiden name.

H. ST. J. SOMERSET, formerly at Mount Morgan, has joined the staff of the Broken Hill Associated Smelters.

W. H. STENTIFORD, secretary of the Forum River and other Nigerian tin companies, has been elected a vice-president of the Chartered Institute of Secretaries.

G. H. THURSTON has left London for Bombay on business connected with electrical power.

J. B. TYRRELL is here from Canada.

SIR HENRY TRUMAN WOOD has recently retired from the Secretaryship of the Royal Society of Arts, which he had held for 38 years, and he is succeeded by G. K. MENZIES.

T. D. MERTON died suddenly last month in London, from a heart attack following rheumatism, at the age of 63. His name is closely associated with roasting problems, and his furnace has been widely applied in zinc metallurgy. He was an Australian by birth. His earliest work was in connection with roasting before chlorination, and subsequently he conducted customs work on arsenical ores.

We regret to record the death of ALFRED PEGLER, the managing director of the Weardale Lead Company.

DR. E. F. ROEBER died on October 17, at the age of 50 years. He was a pioneer of electro-chemistry in America. When the monthly paper, *Electro-chemical Industry*, was founded in 1902, he was made editor, and he held that position during many reorganizations and amalgamations with other papers. The final form of the paper, *Metallurgical and Chemical Engineering*, has achieved a great success, and is in the very front rank of technical publications. He was also one of the founders of the American Electro-chemical Society.

LT.-COL. F. J. TRUMP, D.S.O., was killed in action in France on December 2. He left the position of manager of the Ferreira Deep to join the army. Before he was in Africa he was Government Inspector of Mines in the Cardiff district.

METAL MARKETS

COPPER.—Official prices in this country still remain at £110 to £110. 10s. for standard, £125 to £126 for electrolytic, and £123 to £119 for best selected. In America the official price is still maintained at 23½ cents, but cable reports to hand report sales made at 25 to 30 cents, and bids made at 23½ cents f.o.b. New York for November shipment have been declined on the ground that dealers are sold out for this year. The labour situation is again stated to be mending, but definite news on the subject is wanting. There appears to be sufficient output of metal to meet all requirements, if its use is limited to essential applications and if the reported recovery of production should continue. There is still much controversy as to an increase in the official price, as it is maintained that many of the smaller mines would be compelled to suspend operations unless the present basis is raised. The question of raising the price is in the hands of the War Industries Board, and in the absence of reliable data as to costs and production it is difficult to make any forecast as to their probable course of action. The extent to which production has been increased will no doubt have an important bearing on their decision.

Average prices of cash standard copper: November 1917, £110. 5s. 0d.; October 1917, £110. 5s. 0d.; November 1916, £134. 18s. 2d.

TIN.—This market has shown great strength, prices steadily rising from £258 for cash and three months to £291 cash and £289. 5s. three months. The pace has been led by America where 80 cents has been bid, with no sellers. Stocks in New York are reported to be exhausted and fresh arrangements for distribution are being made to ameliorate the stringency. The position in Batavia is not well understood. They have not been selling in this market, but direct sales appear to have been made to New York for shipment to Pacific ports. The statistical position seems good, but figures are unreliable and compilers have had to fall back on estimates in making up their figures. Considerable anxiety exists as to the restriction of shipping facilities both in the Straits and in Batavia China has sold at full prices, and English is in good request. The present level is considered dangerously high, but the many uncertainties of the shipping position combined with the heavy demand for war purposes make for a continuance of high prices. Much of the arrivals in this country are not available for sale, awaiting export licence, or are held in reserve against consumers' orders.

Average prices of cash standard tin: November 1917, £275. 2s. 10d.; October 1917, £247. 9s. 4d.; November 1916, £186. 19s. 8d.

LEAD. — No change has been made in the official price although the urgency of supplies is unrelieved. The London Metal Exchange has intimated that from January the official price will be a net figure. For convenience of those with contracts based on the previous discounts quotations will be given for the gross figure as well as the net equivalent. Sales are reported from America at 6⅝ cents, and the Trust price is 6½ c. The position there is a good deal dependent on the pending decision as to the Government's price.

Average prices of soft foreign lead: November 1917, £30; October 1917, £30; November 1916, £30.

SPELTER.—The market is inactive but steady. In the United States the situation appears easy, as domestic demand has fallen off, and producers have accumulated stocks against expected Government demands, which have failed to materialize. English spelter is selling at £57 delivered.

Average prices of good ordinary brands: November 1917, £52; October 1917, £52; November 1916, £55 0s. 5d.

SILVER.—The price has varied little during the past month, and stands at 43d. per standard ounce.

NICKEL.—£225 per ton. COBALT.—10s. per lb.

CADMIUM.—8s. per lb. BISMUTH.—11s. per lb.

PLATINUM.—290s. per oz.; scrap 260s. per oz.

CHROMIUM.—Metal 7s. 6d. per lb.; ferro-chrome £80 to £200 per ton according to carbon content.

MANGANESE.—Manganese ore 40½d. per unit.

TUNGSTEN.—Wolfram ore 55s. per unit, 70% WO_3.

MOLYBDENUM.—Molybdenite 105s. per unit, 90% MoS_2.

PRICES OF CHEMICALS. December 10.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d
Alum	per ton	17	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	32	10	0
,, Chloride of, grey	per cwt.	1	18	0
,, ,, ,, pure	,,	3	15	0
,, Nitrate of	per ton	65	0	0
,, Phosphate of	,,	100	0	0
,, Sulphate of	,,	15	10	0
Arsenic, White	,,	130	0	0
Barium Sulphate	,,	6	0	0
Bleaching Powder, 35% Cl.	,,	19	0	0
Borax	,,	37	0	0
Copper, Sulphate of	,,	68	0	0
Cyanide of Potassium, 98%	per lb		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		14	0
Iron, Sulphate of	per ton	9	0	0
Lead, Acetate of, white	,,	130	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	46	0	0
Magnesite, Calcined	,,	14	0	0
Magnesium Sulphate	,,	11	0	0
Phosphoric Acid	per lb.			10
Potassium Carbonate	per ton	165	0	0
,, Chlorate	per lb.		2	6
,, Chloride 80%	per ton	60	0	0
,, Hydrate, (Caustic) 90%	,,	400	0	0
,, Nitrate	,,	75	0	0
,, Permanganate	per lb		15	0
,, Prussiate, Yellow	,,		3	6
,, Sulphate, 90%	per ton	65	0	0
Sodium Metal	per lb.		1	8
,, Acetate	per ton	95	0	0
,, Bicarbonate	,,	8	10	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	4	5	0
,, Hydrate, 76%	,,	26	0	0
,, Hyposulphite	,,	35	0	0
,, Nitrate, 95%	,,	27	0	0
,, Phosphate	,,	35	0	0
,, Silicate	,,	7	0	0
,, Sulphate (Salt-cake)	,,	2	12	6
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	35	0	0
Sulphur, Roll	,,	21	0	0
,, Flowers	,,	23	0	0
Sulphuric Acid, non-arsenical 144°T.	,,	4	5	0
,, non-arsenical 95%	,,	7	0	0
Superphosphate of Lime, 18%	,,	5	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
Year 1916	8,971,359	324,179	9,295,538	39,484,934
January 1917	756,997	25,637	782,634	3,324,418
February	696,955	24,366	721,321	3,063,976
March	760,598	26,496	787,094	3,343,363
April	717,598	25,180	742,778	3,155,121
May	753,531	26,034	779,385	3,310,618
June	732,799	26,925	759,724	3,227,101
July	731,848	25,991	757,839	3,219,094
August	731,405	25,253	756,658	3,214,079
September	712,881	25,350	738,231	3,135,807
October	724,846	26,444	751,290	3,191,279
November	698,271	24,568	722,839	3,070 426

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1916	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500
October 31	199,330	10,907	6,358	216,595
November 30	196,132	11,118	5,928	213,178
December 31	191,547	11,487	5,194	208,228
January 31, 1917	188,624	11,611	5,591	205,826
February 28	191,095	11,568	6,268	208,931
March 31	190,028	11,494	6,620	208,142
April 30	185,975	11,435	6,314	203,724
May 31	180,168	11,432	5,805	197,405
June 30	175,727	11,258	5,369	192,354
July 31	171,653	11,381	5,223	188,257
August 31	170,817	11,401	5,028	187,246
September 30	171,334	11,601	4,791	187,726
October 31	170,331	11,841	4,620	186,792
November 30	169,083	11,633	4,620	185,336

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
July 1916	2,370,244	26 1	17 10	8 0	949,606
August	2,423,669	26 3	17 10	8 1	976,125
September	2,367,793	26 6	18 0	8 3	972,704
October	2,453,437	26 4	17 10	8 2	1,001,843
November	2,389,056	26 9	18 2	8 2	980,387
December	2,349,191	26 10	18 2	8 4	977,481
January 1917	2,337,066	26 10	18 8	7 11	941,520
February	2,153,691	27 3	19 2	7 10	841,259
March	2,430,590	26 7	19 0	7 4	879,351
April	2,235,833	27 2	19 2	7 8	857,710
May	2,405,855	26 4	18 7	7 5	887,527
June	2,288,426	26 11	19 2	7 7	867,639
July	2,294,668	26 11	19 0	7 7	869,577
August	2,301,892	26 9	19 0	7 6	859,517

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1916	1917	1916	1917
	£	£	£	£
January	318,586	296,113	140,579	131,665
February	313,769	289,734	137,739	104,892
March	335,368	300,183	150,987	158,727
April	339,386	297,977	135,976	123,825
May	323,783	299,271	132,976	121,104
June	333,070	302,195	127,107	114,489
July	322,365	288,731	128,574	142,017
August	338,001	294,359	125,143	130,278
September	322,035	291,367	127,138	127,168
October	325,608	289,978	132,577	126,295
November	317,135	...	130,101	...
December	306,205	...	146,409	...
Total	3,895,311	2,948,908	1,615,356	1,280,460

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January 1917	*	83,962	*	*
February	*	81,810	*	*
March	*	76,171	*	*
April	*	82,144	*	*
May	*	78,165	*	*
June	*	82,600	*	*
July	*	81,166	*	*
August	*	80,181	*	*
September	*	81,761	*	*
October	*	73,901	*	*
November	*	80,642	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1916	1917	1916	1917	1916	1917
	£	£	£	£	£	£
January	89,900	67,627	66,700	50,150	39,000	29,000
February	76,500	65,450	79,050	63,200	30,000	26,000
March	103,600	74,794	76,920	61,200	36,000	41,000
April	60,000	75,139	83,300	62,470	63,000	21,000
May	119,500	65,623	116,230	65,450	19,000	28,400
June	86,000	64,180	72,200	73,100	18,000	24,600
July	100,600	68,937	85,400	71,820	23,000	44,000
August	66,800	...	86,000	74,800	24,000	21,000
September	115,100	...	65,450	64,180	32,000	20,000
October	81,400	...	74,800	54,400	32,000	47,000
November	94,000	...	60,300	...	31,000	...
December	96,600	...	73,550	...	111,000	..
Total	1,090,000	481,373	939,900	674,170	458,000	301,000

Production of Gold in India.

	1914	1915	1916	1917
	£	£	£	£
January	193,140	201,255	192,150	190,047
February	185,508	195,970	183,264	180,904
March	191,853	194,350	186,475	189,618
April	189,197	196,747	192,208	185,835
May	193,031	199,786	193,604	184,874
June	192,224	197,447	192,469	182,426
July	195,137	197,056	191,404	179,660
August	196,560	197,984	192,784	181,005
September	195,843	195,952	192,330	183,630
October	198,191	195,531	191,502	182,924
November	197,699	192,714	192,298	...
December	211,911	204,590	205,164	...
Total	2,340,294	2,369,382	2,305,652	1,840,923

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper Standard	Copper Electrolytic	Copper Best Select'd	Soft For'n Lead	Zinc	Tin Standard	Silver
Nov.	£	£	£	£ s.	£ s.	£ s. d.	d.
12	110	125	123	30 10	54 0	269 0 0	$43\frac{3}{4}$
13	110	125	123	30 10	54 0	273 15 0	$43\frac{5}{8}$
14	110	125	123	30 10	54 0	278 5 0	$43\frac{5}{8}$
15	110	125	123	30 10	54 0	277 0 0	$43\frac{1}{2}$
16	110	125	123	30 10	54 0	276 15 0	$43\frac{1}{2}$
19	110	125	123	30 10	54 0	276 0 0	$43\frac{3}{8}$
20	110	125	123	30 10	54 0	279 10 0	$43\frac{1}{4}$
21	110	125	123	30 10	54 0	285 0 0	$43\frac{1}{4}$
22	110	125	123	30 10	54 0	282 10 0	$42\frac{15}{16}$
23	110	125	123	30 10	54 0	282 10 0	$42\frac{15}{16}$
26	110	125	123	30 10	54 0	283 10 0	$42\frac{3}{4}$
27	110	125	123	30 10	54 0	284 0 0	$42\frac{3}{4}$
28	110	125	123	30 10	54 0	286 0 0	$42\frac{3}{4}$
29	110	125	123	30 10	54 0	290 0 0	$42\frac{3}{4}$
30	110	125	123	30 10	54 0	291 0 0	$42\frac{3}{4}$
Dec.							
3	110	125	123	30 10	54 0	294 0 0	$42\frac{3}{4}$
4	110	125	123	30 10	54 0	293 10 0	$42\frac{3}{4}$
5	110	125	123	30 10	54 0	294 10 0	$42\frac{3}{4}$
6	110	125	123	30 10	54 0	292 0 0	$42\frac{3}{4}$
7	110	125	123	30 10	54 0	293 10 0	43
10	110	125	123	30 10	54 0	296 0 0	$42\frac{7}{8}$
11	110	125	123	30 10	54 0	298 0 0	$42\frac{7}{8}$

Imports of Ores and Metals into United Kingdom.

These figures now include Government imports.

* Statistics not published. Long tons.

	Year 1916	Oct. 1917	Year 1917
	Tons	Tons	Tons
Iron Ore	6,905,936	*	*
Copper Ore	34,492	*	*
„ Matte and Precipitate	43,839	2,340	21,264
„ Metal	111,412	10,041	107,844
Copper and Iron Pyrite	951,206	*	*
Tin Concentrate	33,912	*	*
„ Metal	33,646	3,756	24,274
Manganese Ore	439,509	*	*
Lead, Pig and Sheet	157,985	14,656	120,456
Zinc (spelter)	53,324	13,390	59,537
	lb.	lb.	lb.
Quicksilver	2,556,214	1,875	1,798,310

Exports of Copper from United States

These figures are circulated by news agencies and it is not always possible to verify their correctness. No figures are available since June.

1916	Long tons	1916	Long tons	1917	Long tons
January	21,863	July	35,048	January	25,540
February	20,548	August	34,700	February	24,937
March	24,006	September	28,572	March	51,246
April	19,980	October	32,712	April	79,001
May	14,700	November	21,433	May	45,241
June	38,277	December	21,438	June	39,816
		Total 1916	313,277	Total 1917	265,783

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1916 Tons	Oct. 1917 Tons	Year 1917 to date
Bisichi (Nigeria)	473	20	228
Briseis (Tasmania)	467	16	290
Dolcoath (Cornwall)	1,076	61	709
East Pool (Cornwall)*	1,012	80	854
Gopeng (F.M.S.)	1,113	86	885
Malayan Tin (F.M.S.)	1,104	84	685
Mongu (Nigeria)	576	50	471
Naraguta (Nigeria)	523	45	413
N. N. Bauchi (Nigeria)	578	50	455
Pahang (F.M.S.)	2,591	185	2,115
Rayfield (Nigeria)	658	60	530
Renong (Siam)	894	82	850
Siamese Tin (Siam)	906	63	680
South Crofty (Cornwall)*	700	60	576
Tekka-Taiping (F.M.S.)	651	42	355
Tongkah Harbour (Siam)	1,135	85	1,003
Tronoh (F.M.S.)	1,662	84	877

* Including Wolfram.

Stocks of Tin.

Reported by A. Strauss & Co Long tons.

	Sept. 30, 1917	Oct. 31, 1917	Nov. 30, 1917
	Tons	Tons	Tons
Straits and Australian, Spot	2,031	2,660	3,688
Ditto, Landing and in Transit	263	2,240	500
Other Standard, Spot and Landing	947	915	703
Straits, Afloat	6,420	*3,825	*4,500
Australian, Afloat	—	—	—
Banca, on Warrants	—	—	—
Ditto, Afloat	1,620	*1,670	*2,600
Billiton, Spot	—	—	
Ditto, Afloat	300	*200	*300
Straits, Spot in Holland and Hamburg	—	—	
Ditto, Afloat to Continent	1,050	1,000	*1[illegible]
Afloat for United States	4,547	*4,325	*5,727
Stock in America	2,397	1,657	1,592
Total Stock	19,575	18,402	20,610

* Estimated.

Shipments and Imports of Tin

Reported by A. Strauss & Co. Long tons.

	Year 1916	Nov. 1917	Total 1917
	Tons	Tons	Tons
Shipments from:			
Straits to U.K.	27,157	*2,300	26,099
Straits to America	25,943	*2,300	22,477
Straits to Continent	8,487	*500	8,790
Australia to U.K.	2,537	—	349
U.K., Holland, and Continent to America	14,863	910	11,830
Imports of Bolivian Tin into Europe	15,116	2,984	17,992
Deliveries in U.K.	16,862	1,750	13,446
„ „ Holland	943	*50	1,667

* Estimated.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1912	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531	667
February	240	427	469	358	528	646
March	247	510	502	418	547	655
April	141	430	482	444	486	555
May	144	360	480	357	536	509
June	121	321	460	373	510	473
July	140	357	432	455	506	465
August	201	406	228	438	498	536
September	196	422	289	442	535	500
October	256	480	272	511	584	549
November	340	445	283	467	679	...
December	310	478	326	533	654	...
Total	2,540	5,103	4,708	5,213	6,594	5,555

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. No figures published since June.

	1913	1914	1915	1916	1917
	Tons	Tons	Tons	Tons	Tons
January	4,121	4,983	4,395	4,316	3,558
February	3,823	3,555	3,780	3,372	2,755
March	3,562	3,839	3,653	3,696	3,286
April	4,066	4,087	3,619	3,177	3,251
May	4,319	4,135	3,823	3,729	3,413
June	3,993	4,303	4,048	3,435	3,489
July	4,245	4,582	3,544	3,517	...
August	4,620	3,591	4,046	3,732	...
September	4,379	3,623	3,932	3,636	...
October	4,409	3,908	3,797	3,681	...
November	3,976	4,085	4,059	3,635	...
December	4,614	4,351	4,071	3,945	...
	50,127	49,042	46,767	43,871	19,752

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
January 2, 1917	176	£17,677	£100 8 10
January 15	160¾	£16,681	£103 15 5
January 29	152	£16,095	£105 17 10
February 12	182¼	£20,649	£113 6 1
February 26	176¾	£19,700	£111 9 3
March 12	179	£20,468	£114 7 0
March 26	161¾	£19,875	£122 17 8
April 10	179	£22,024	£123 2 0
April 23	169	£21,429	£126 16 0
May 7	167	£22,248	£133 4 6
May 21	168¼	£23,772	£141 5 9
June 4	168	£22,474	£133 15 6
June 18	158½	£21,915	£138 5 4
July 2	159½	£21,661	£135 16 1
July 16	144¼	£18,896	£130 19 11
July 30	168	£23,225	£138 5 0
August 13	160¼	£21,757	£135 15 4
August 27	156½	£21,429	£136 18 6
September 10	160¼	£21,784	£135 18 9
September 24	153	£21,448	£140 3 9
October 8	160½	£22,160	£138 11 6
October 22	153	£21,712	£141 18 2
November 6	144¼	£21,063	£146 0 5
November 19	156	£24,737	£158 11 6
December 3	148	£24,609	£165 5 6

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:

	Dec. 5, 1916 £ s. d.	Dec. 5, 1917 £ s. d.
RAND:		
Bantjes	13 3	3 0
Brakpan	5 0 0	5 13 0
Central Mining (£8)	7 0 0	6 10 0
Cinderella	6 0	4 6
City & Suburban (£4)	1 17 6	1 6 3
City Deep	4 5 6	3 8 0
Consolidated Gold Fields	1 10 6	1 11 3
Consolidated Langlaagte	1 8 9	1 1 6
Consolidated Main Reef	18 6	15 6
Consolidated Mines Selection (10s).	1 3 6	1 8 6
Crown Mines (10s.)	3 0 0	2 2 6
Daggafontein	15 3	1 10 0
D. Roodepoort Deep	12 0	10 0
East Rand Proprietary	14 6	5 9
Ferreira Deep	1 3 0	15 0
Geduld	2 4 0	1 19 6
Geldenhuis Deep	1 2 6	18 9
Gov't Gold Mining Areas	2 11 3	3 13 0
Heriot	2 11 3	1 16 3
Jupiter	7 6	5 0
Kleinfontein	1 7 6	1 1 6
Knight Central	10 9	3 0
Knight's Deep	1 6 3	10 0
Langlaagte Estate	17 0	15 0
Main Reef West	5 0	3 0
Meyer & Charlton	5 11 3	5 8 9
Modderfontein (£4)	18 16 3	23 2 6
Modderfontein B	7 5 0	8 15 0
Modder Deep	7 7 6	7 10 0
Nourse	1 0 0	1 1 3
Rand Mines (5s.)	5 12 6	3 0 0
Rand Selection Corporation	3 16 3	4 13 9
Randfontein Central	11 6	11 3
Robinson (£5)	17 6	18 9
Robinson Deep	1 15 0	1 6 3
Rose Deep	1 1 3	19 6
Simmer & Jack	6 9	6 0
Simmer Deep	4 6	2 9
Springs	3 3 9	3 17 0
Sub-Nigel	1 8 9	1 8 9
Van Ryn	1 19 6	1 10 6
Van Ryn Deep	3 9 6	3 13 9
Village Deep	1 10 0	1 1 3
Village Main Reef	16 6	14 9
Witwatersrand (Knight's)	2 13 9	1 17 6
Witwatersrand Deep	1 1 6	7 6
Wolhuter	10 9	7 6
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	15 0	1 0 0
Sheba (5s.)	1 9	1 3
Transvaal Gold Mining Estates	19 6	18 6
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	13 10 0	13 0 0
Jagersfontein	4 1 3	4 5 0
Premier Deferred (2s. 6d.)	7 2 6	7 12 6
RHODESIA:		
Cam & Motor	11 6	10 6
Chartered British South Africa	11 0	14 6
Eldorado	8 3	7 6
Falcon	14 9	17 6
Gaika	8 6	6 3
Giant	7 3	6 6
Globe & Phœnix (5s.)	1 17 6	1 11 3
Lonely Reef	18 6	1 11 0
Rezende	8 9	4 5 0
Shamva	19 6	1 13 0
Wanderer (3s.)	1 3	2 0
Willoughby's (10s.)	4 0	5 6
WEST AFRICA:		
Abbontiakoon (10s.)	5 0	4 0
Abosso	8 6	8 0
Ashanti (4s.)	19 3	1 1 6
Prestea Block A	7 0	5 0
Taquah	17 6	17 6
WEST AUSTRALIA:		
Associated Gold Mines	4 0	2 6
Associated Northern Blocks	3 0	2 6
Bullfinch	3 0	2 0
Golden Horse-Shoe (£5)	1 17 0	2 6 3
Great Boulder Proprietary (2s.)	12 0	13 3
Great Boulder Perseverance	6	6
Great Fingall (10s).	1 3	1 3
Ivanhoe (£5)	2 2 6	2 4 6
Kalgurli	10 6	10 0
Sons of Gwalia	14 3	12 6

GOLD, SILVER, *cont.*	Dec. 5, 1916 £ s. d.	Dec. 5, 1917 £ s. d.
OTHERS IN AUSTRALASIA:		
Mount Boppy, New South Wales	7 6	6 0
Talisman, New Zealand	10 0	12 6
Waihi, New Zealand	1 15 0	1 18 3
Waihi Grand Junction, New Z'lnd	15 9	16 6
AMERICA:		
Alaska Treadwell (£5), Alaska	2 15 0	—
Buena Tierra, Mexico	12 6	9 0
Camp Bird, Colorado	6 6	7 0
Casey Cobalt, Ontario	5 6	7 3
El Oro, Mexico	7 6	8 9
Esperanza, Mexico	9 9	8 3
Frontino & Bolivia, Colombia	12 6	12 6
Le Roi No. 2 (£5), British Columbia	9 6	6 3
Mexico Mines of El Oro, Mexico	3 10 0	5 18 9
Oroville Dredging, California	15 9	19 3
Plymouth Consolidated, California	1 0 0	1 2 6
St. John del Rey, Brazil	16 3	18 6
Santa Gertrudis, Mexico	9 0	13 0
Tomboy, Colorado	1 1 3	1 0 9
RUSSIA:		
Lena Goldfields	1 13 9	1 10 0
Orsk Priority	1 1 3	12 6
INDIA:		
Champion Reef (2s. 6d.)	6 6	5 3
Mysore (10s.)	3 8 9	3 0 6
Nundydroog (10s.)	1 5 6	1 4 9
Ooregum (10s.)	1 0 6	19 0

COPPER:

	Dec. 5, 1916 £ s. d.	Dec. 5, 1917 £ s. d.
Arizona Copper (5s.), Arizona	2 6 3	2 7 0
Cape Copper (£2), Cape Province	4 15 0	3 0 0
Chillagoe (10s.), Queensland	3	3
Cordoba (5s.), Spain	4 0	3 6
Great Cobar (£5), N.S.W.	2 3	1 6
Hampden Cloncurry, Queensland	1 15 3	1 8 9
Kyshtim, Russia	2 6 3	1 13 9
Messina (5s.), Transvaal	10 6	8 6
Mount Elliott (£5), Queensland	6 0 0	4 0 0
Mount Lyell, Tasmania	1 6 0	1 8 3
Mount Morgan, Queensland	1 12 0	1 14 0
Rio Tinto (£5), Spain	64 5 0	63 10 0
Sissert, Russia	1 3 9	1 2 6
Spassky, Russia	1 17 6	1 7 6
Tanalyk, Russia	2 10 0	1 8 9
Tanganyika, Congo and Rhodesia	2 10 6	3 10 6
Tharsis (£2), Spain	5 5 0	5 10 0

LEAD-ZINC:

	Dec. 5, 1916 £ s. d.	Dec. 5, 1917 £ s. d.
BROKEN HILL:		
Amalgamated Zinc	1 11 6	1 11 9
British Broken Hill	1 6 6	1 16 0
Broken Hill Proprietary (8s.)	2 12 6	2 13 6
Broken Hill Block 10 (£10)	1 0 3	1 4 6
Broken Hill North	2 8 6	2 15 9
Broken Hill South	8 15 0	9 10 0
Sulphide Corporation (15s.)	1 9 9	1 9 3
Zinc Corporation (10s.)	15 6	19 6
ASIA:		
Burma Corporation	3 10 0	3 18 0
Irtysh Corporation	2 0 0	1 10 0
Russian Mining	16 3	12 6
Russo-Asiatic	4 17 6	3 5 0

TIN:

	Dec. 5, 1916 £ s. d.	Dec. 5, 1917 £ s. d.
Aramayo Francke, Bolivia	1 7 6	1 13 9
Bisichi, Nigeria	12 0	15 3
Briseis, Tasmania	5 0	5 6
Dolcoath, Cornwall	9 9	11 0
*East Pool, Cornwall	1 13 9	14 0
Ex-Lands Nigeria (2s.), Nigeria	1 9	2 6
Geevor (10s.) Cornwall	9 0	19 0
Gopeng, Malay	1 10 0	1 12 6
Ipoh Dredging, Malay	16 3	16 9
Malayan Tin Dredging, Malay	2 0 0	2 2 6
Mongu (10s.), Nigeria	9 6	15 9
Naraguta, Nigeria	14 6	18 6
N. N. Bauchi Pref. (10s.), Nigeria	7 9	13 0
Pahang Consolidated (5s.), Malay.	10 9	12 6
Rayfield, Nigeria	7 6	12 9
Renong Dredging, Siam	2 5 6	2 8 9
Ropp (4s.), Nigeria	17 6	19 6
Siamese Tin, Siam	2 10 0	3 0 0
South Crofty (5s.), Cornwall	14 6	1 1 6
Tekka, Malay	3 5 0	3 12 6
Tekka-Taiping, Malay	3 1 3	3 15 0
Tronoh, Malay	1 11 3	1 10 0

* £1 shares split into 4 of 5s. each in August 1917.

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

FURNACES FOR ROASTING BLENDE.

In the *Engineering and Mining Journal* for October 20, M. F. Chase, of St. Louis, discusses recent developments of furnaces for roasting blende and the principles regulating the selection of any particular design according to the nature of the material to be roasted and the result to be effected. We quote this interesting article at length.

Probably more than 100 different types of furnaces have been tried for roasting blende. Of these not more than 15 distinct kinds are being used at present. In many cases the failure of a furnace has been due to a lack of understanding, on the designer's part, of the problem involved; in others, to the use of unsuitable materials. In designing any metallurgical furnace the engineer is apt to be handicapped in obtaining suitable material to use in the structure. Frequently this is caused by the excessive cost of what he would like to use, but more often it is due to the fact that there is not any ideal material for his special work. This is particularly true in the case of the construction of a blende-roasting furnace. Great difficulties have been encountered in getting refractories to withstand the conditions under which it is necessary to operate a roasting furnace, and undoubtedly some types of furnaces have been prematurely discarded because of failures due to the firebrick used. The same is true of the materials used to build the moving parts of mechanical furnaces. Besides this there seems to have been a lack of appreciation of the importance of conserving the heat produced from the roasting reaction, and when attempts have been made to accomplish this, many of them, especially in muffled furnaces, have been without a thorough analysis of the problem. In some muffled roasters the fuel gases actually take heat away from the sulphur gases. However, the greatest trouble generally has been with the draught and air-intake regulation.

To roast blende it is necessary to bring each particle of ore to a temperature sufficiently high to ignite and burn it, and also to bring it in contact with sufficient oxygen to oxidize completely the metals and the sulphur. The temperature necessary is between 700° and 800°C., and the heat is supplied by fuel and the combustion of the sulphur. The oxygen contact with the ore is obtained by rabbling or stirring. Theoretically, sufficient heat can be obtained by the oxidation of the sulphur, provided the sulphur gases are removed from the furnace at a concentration of 5% SO_2 or better. So far no furnace has been constructed to utilize this heat fully, and it has been necessary to apply external heat. This, while not being difficult in reverberatory furnaces of all kinds, has given a great deal of trouble in the mechanically raked muffles. The fuel requirements figured to bituminous coal vary anywhere from 8 to 35% of the ore charged. Under proper conditions a complete roast of an average blende can be had without the temperature of the ore ever being above 800°C. If the temperature during any period of the roasting is allowed to go much over this, many ores have a tendency to fuse and the roast cannot be completed. From many furnaces fused concentrate has been taken, which showed an entirely unaltered core of blende. If the temperature is lower than 700°C. and the ore is still in contact with sulphur gases, sulphates are formed which are hard to break up. The ore should be kept at a temperature between 700° and 800°C. until it is completely desulphurized. This means that the air for burning the sulphur should be preheated before it is admitted in the final stages of the roasting process. Part of the heat for heating this air can be supplied from the hot roasted ore.

In order to get the greatest capacity out of the roasting furnace per square foot of hearth area, the ore should be heated as rapidly as possible to the proper roasting temperature. In some of the old, hand-rabbled, muffled furnaces this result is obtained with a low coal consumption by taking the fire gases over the top hearth. The main objection to this has always been the high temperature of the sulphur gases as they leave the furnace. It is doubtful, however, if this objection is important, as the cooling can be so readily done afterward in an apparatus that is much cheaper than the roasting furnace itself.

To maintain proper roasting conditions it is necessary that the ore be completely and continuously stirred and rabbled. This has been the first big problem to confront the designer of mechanical furnaces of both reverberatory and muffled types. The natural material from which to make the rabbles or stirrers was iron. It was found, when ordinary cast iron was used, that the stirring rabbles burned out rapidly. This was overcome by cooling the rabbles either by removing them from the furnace periodically, thus causing intermittent rabbling in muffled furnaces—though the removal could be accomplished successfully in reverberatory furnaces—or by cooling by circulating air, water, or steam through them, thus causing considerable reduction in the furnace temperature and an appreciable heat loss, especially when water was the cooling medium. Only recently has this latter method proved to be satisfactory when used in a muffled furnace. The problem was approached in two other ways. One was to make the rabbles of firebrick, as in the Spirlet, and the other to use a special iron mixture as in the Merton. In addition to the material of construction, much depends on the shape of the stirrer and the way in which the stirring is done. Improper rabbling will cause high dust losses and also excessive hearth accretions. A certain amount of these cannot be avoided, but no doubt they can be materially reduced by certain interior flue constructions and by a good system of rabbling.

In most furnaces the design of the movable parts has been such as to require the roof to be raised to a considerable height above the hearth. This is one of the chief sources of loss of heat in the Ropp reverberatory furnace. A roof arch here spans the firebox and the roasting hearths, and this, with the rake mechanism, tends to bring the top of the arch so far from the ore as to rob the combustion gases of a part of their effectiveness. Hence the conditions in this furnace are such as to lead to a high fuel cost, although the labour cost is extremely low, only one man being required for 12 hours per furnace. The Zellweger, Cappeau, and Brown furnaces are more or less similar to the Ropp and have this same objection. All of these types of furnace have been modified more or less by different builders. The builders, however, have devoted themselves principally to working out the mechanical equipment of the furnace rather than to trying to conserve the heat. In this respect only slight changes have been made, such as the different methods employed to supply air for the combustion of the fuel gases and for the burning of the sulphur. In some cases considerable gain has been made in the capacity of the furnaces by these modifications. It may be said of all the furnaces of this general type that they have been extremely well worked out mechanically and can be operated economically with cheap fuel, preferably with natural gas. They are not expensive to construct, and under the conditions above stated, where the sulphur gases are to be wasted, a modified Ropp, such as those built in the south-west of the United States, is probably the best reverberatory furnace. If fuel is expensive, then a type similar to the Merton, Ridge, or Wedge should be used. The Merton and Ridge reverberatory furnaces take considerably less fuel than does the Ropp and the repairs are somewhat higher. The former furnaces are more expensive to build. They probably are more satisfactory, from the standpoint of fuel economy, than the straight-line furnaces as used in the United States, and have been used in Australia and Russia. One of the last big installations of reverberatory roasters was that recently completed in Siberia, where the Merton furnaces were used. The Merton, as first installed, had to be re-designed and strengthened mechanically, but the present furnace apparently is doing fair work. Any one of these furnaces, as now designed, if built of the proper materials, should be economical where fuel is high.

There is no record of any Wedge furnace being used for roasting blende where the fuel gases are directly in contact with the ore. However, there is no reason why it should not be as good a furnace for roasting blende, under these conditions, as either the Ridge or the Merton; both of these furnaces have been successfully used in this way.

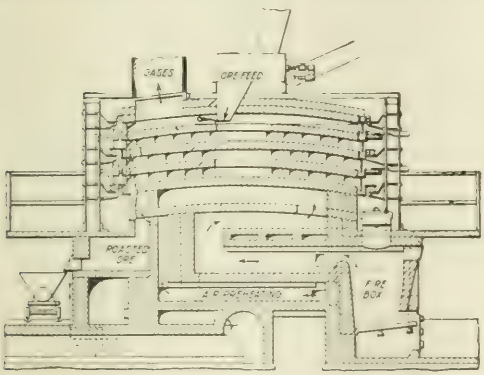
There are a limited number of mechanical, muffled furnaces in commercial use at present, and fewer types of the hand-raked muffles. These latter are being gradually replaced by mechanical furnaces. The Delplace is an exceptionally good hand-raked furnace and is often considered superior to some of the mechanical roasters. In fact, De Lummen has figured that the Delplace furnace would roast for 2s. per ton less than the Hegeler. Unfortunately, in making this comparison De Lummen could not have had accurate data on the Hegeler furnace, as prior to the war the working cost of a number of Hegeler furnaces was considerably under 8s. per ton, but the fact probably remains that the Delplace furnaces are being operated more cheaply in some plants than the Hegeler or other mechanical furnaces are being operated in others, due consideration being given to the different labour and fuel conditions under which the operations are conducted.

In most cases, unless conditions are exceptional, the proper type of muffled roasting furnace to install would be a mechanical one. Of the mechanical furnaces the general kinds to choose from are: The Hegeler, Spirlet, Ridge, Wedge, and Huntington-Heberlein. Of these five, the Hegeler, the Spirlet, and the Ridge are being used to roast blende for spelter manufacture. The Wedge, as used at present, is a combination of the muffled and reverberatory types of furnaces, but there is no reason why it cannot be modified, in order to do away with the reverberatory feature, and become similar in type to the Huntington-Heberlein, which, although more or less in the formative stage, still has possibilities of success, in view of the operation of the Ridge rabble-cooling system. If one were required to build a furnace free from any experimental features, the choice would be limited to the Hegeler, Spirlet, and Ridge, regardless of the fact that other types appear to have the possibility of being developed into commercial furnaces.

The Hegeler furnace has been used extensively, in fact almost exclusively, in the United States and to some extent in Germany and Australia. It is a large-tonnage furnace, cannot be economically used on less than 30 tons per day, and may be used up to 50 tons per day. The original Hegeler patent (U. S. No. 303,571) was applied for in 1882; since that time the furnace has been changed in many respects, and in hardly any two installations is it exactly alike. The name Hegeler, when applied to a roasting furnace, does not mean a certain definite structure; it refers only to a very general type. Almost every Hegeler furnace is different, not only in the minor points but also in many important features. For instance, there are used at the present time three totally different systems of firing and three systems of operating machinery, while there are almost as many air-regulating methods as there are furnaces. Besides these, many details, such as the design of the doors, location and size of drop holes, construction of arches, and shape of rakes are different. [The Hegeler furnace, as applied at the Port Pirie works of the Broken Hill Associated Smelters, was described in the Magazine for January, 1914.] Every possible objection has been urged against the Hegeler furnace, among which may be mentioned these: It is difficult to regulate and expensive to build; it takes a comparatively large amount of room and is awkward in shape; it is difficult to arrange for easy and cheap handling of ore; it gives a fluctuating SO_2 gas; and its fuel consumption is high. Regardless of all of these faults, if it is properly built, in the hands of trained men this furnace can be operated to produce a well-roasted product at a low operating and maintenance cost. Its size is such that it is not easy to control and, once it gets out of order, time is required to get it straightened out. It does take considerable space, and the SO_2 gas varies to such an extent as to affect the acid system, and on fixed draught it is almost impossible to get an average gas of much over 4%. In chamber-acid work, if operating with fans, it is possible to get 5% or over as an average gas. There is often trouble with the air regulation, and at times a considerable portion of green ore is drawn, which has to be re-charged. The hearth accretions are heavy, and the hearths must be kept continually chiseled. Much depends on the details of design and the specifications of materials, and neglect in many things, which might be easily considered minor, will lead to endless trouble in operation and high expense of maintenance. The efficient operation of a Hegeler furnace is largely a matter of skilled operators, of whom it takes eight when working eight-hour shifts. In the hands of inexperienced men the roasting results and cost will be extremely disappointing.

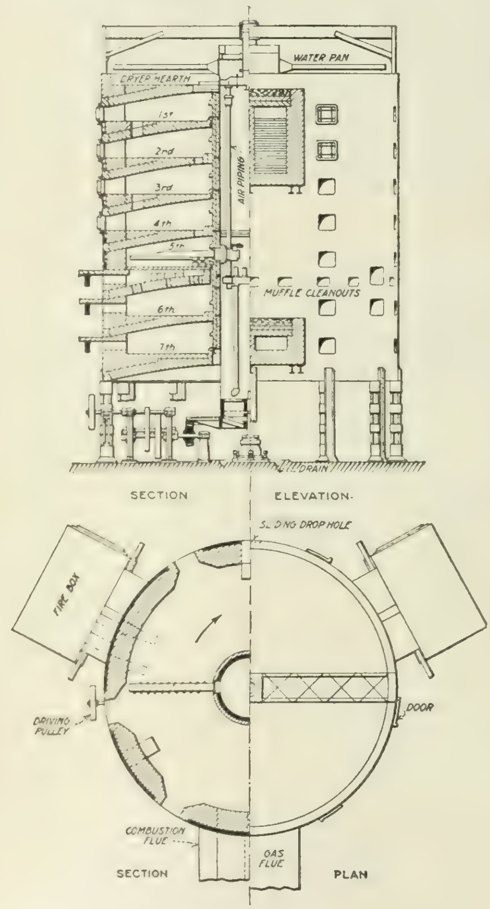
The Ridge and the Spirlet furnaces were previously mentioned with the Hegeler as types of mechanical furnaces to use in roasting blende for spelter, and they merit a brief description. The Ridge has five hearths, one for drying and heating the ore, three for roasting (the fourth being a muffled hearth) and one for cooling the ore and preheating the air. [For a description and drawings of the Ridge furnace see the Magazine for April, 1917, page 221.] The ore is moved from hearth to hearth by rabbles hung on arms fastened to hollow, water-cooled columns, which require about 15,000 gal. of cooling water for every 24 hours of operation. There are four of these shafts to each furnace and each shaft is driven from the bottom by bevel gears. There are four arms to each hearth except the cooling hearth, where only three are used. The ore is fed continuously to the top or preheating hearth, travelling from the feed hopper to the opening of the first hearth, back along that hearth, and so on to the cooling hearth, where it is finally discharged. The discharge opening is to one side of the longitudinal centre line and behind a brick wall which protects the gearing from the dust and the heat. The roasted product, when Broken Hill concentrates were used, reached a tenor of total sulphur as low as 0·75% on a 10% consumption of coal in the producers. The SO_2 content in the sulphur gases averages $6\frac{1}{2}$ to $8\frac{1}{2}$%. About 10 h.p. is required to operate one of these furnaces.

The Spirlet roasting furnace has several rotating hearths, projections from one making the rabbles for the hearth beneath. There are not any metal parts exposed to the hot gases, as the rabbles are made of special fireclay shapes which can be removed only by closing down the furnace and cooling it off. The working period for one of these furnaces is usually about three months, and then, because of wear and breakage in the rabbles, the furnace has to be closed down and cooled off before the rabbles can be removed. The last hearth is muffled and has the roasted ore discharging from the periphery into a hopper where part of the heat is extracted to preheat the air, the remainder of the heat in the air being obtained from the firebox. This furnace consumes about 10% of coal as fuel, requiring about 2 h.p. to operate a five-ton furnace, and gives a gas high in SO_2 with a loss of 1 to 2% of zinc in the dust. The furnace is limited as to size, and there is considerable difficulty in changing the form of the rabble in case of changing the kind of ore charged to the furnace.



The Spirlet Furnace.

The Wedge furnace for roasting blende for sulphuric acid is, as stated, a combination of the muffled and the reverberatory, similar in principle to the Repath patent (U. S. No. 785,437). This idea was first used by the Vieille Montagne a great many years ago, but was soon abandoned. Though the design has been suggested time and again, the Wedge Mechanical Furnace Co. was the first to operate successfully a furnace on this principle. On the lower hearths the combustion gases come in direct contact with the ore. Up to the present time there have been a number of these furnaces built, but in every case except one the roasted blende has been used in a leaching process. There are no available data as to the amount of sulphur as sulphate remaining in the roasted ore. This is so important in the subsequent spelter-furnace work that until it is found that it can be kept below the allowable limit there will always be some doubt as to the usefulness of the furnace for roasting for spelter purposes. There are two installations in the United States that will soon be operating on spelter ores, and before long the data will be available.



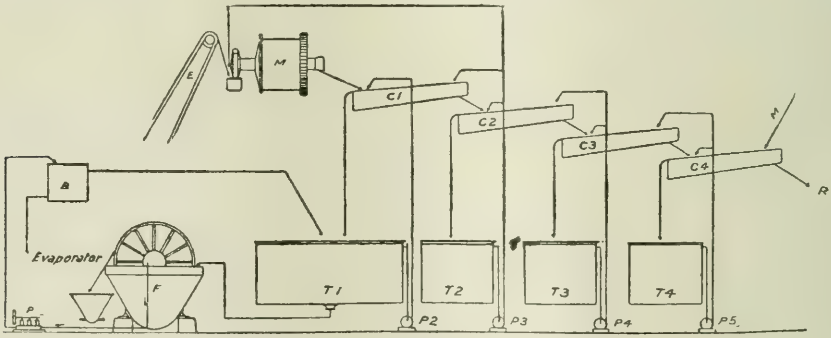
The Wedge Furnace.

The Huntington-Heberlein furnace, which is a straight-muffled type of turret furnace, is now being tried in England. Its special features are the methods of air admission and certain mechanical details in the construction of the rabble holders and operating machinery. In both the Wedge and Huntington-Heberlein furnaces attempts are made to conserve the excess heat generated in the upper hearths. One of the difficulties with furnaces of this type has always been the regulation of the air supply. In roasting, the air or gas must be continually removed from the surface of the ore. This is accomplished by having as high a velocity of the gas as consistent with minimum dusting and high percentage of SO_2. This requires that the muffles be low. In furnaces of this character a low muffle is difficult to obtain, and in addition there is always danger of unequal distribution of the gas current over the bed of the ore. In the Spirlet furnace this difficulty has been overcome by making a roof of each hearth to carry the rabble blades.

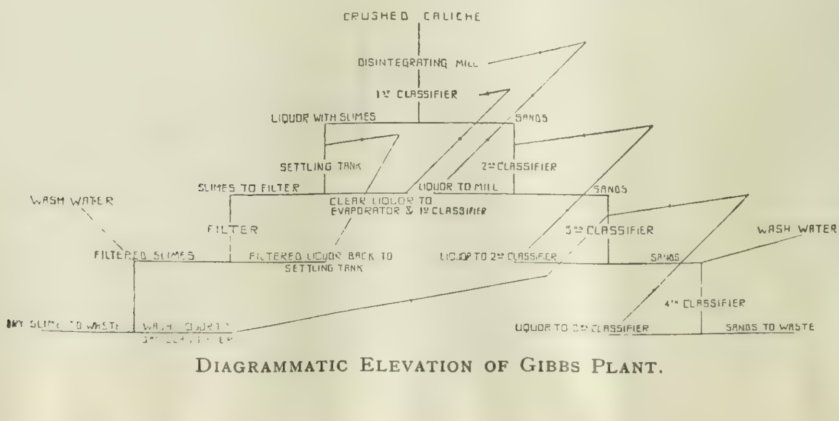
To determine the best type of furnace to use under any given set of conditions one must consider: (1) the proper roasting of the ore, and (2) the suitability of the gas for making acid. The first cost and the working cost are of less importance. Well-roasted ore is of the utmost importance to the smelter, as a high sulphur content directly affects the metal recovery, and a loss here could not be offset by any gain made in the acid systems by using a better gas. From the standpoint of working efficiency a furnace should produce a high, uniform SO_2 gas, free from dust, and a low-sulphur roasted product free from lumps and fritted masses of ore. From the standpoint of economy the excess heat in the first stage of the roasting should be transferred to the final stages. In order to get these results a kiln must be constructed so that the following conditions are complied with: (1) The ore must be rabbled continuously; (2) the arches must be low, so that the gas travelling over the ore continually sweeps away the SO_2 in contact with it; (3) the ore must not fall through the ascending current of gas; (4) the air must be introduced hot; (5) the temperature of the different hearths must be readily controlled by regulating the air supply; (6) the ore should be cooled by air later used for roasting; and (7) the rabbles should be easily accessible and be capable of being quickly changed. The structure must take only a small amount of floor space to permit the cheap handling of the ore to a battery of furnaces. When judged in this manner it is found that no furnace fully fills the required conditions, and the furnace chosen, no matter what it is, will surely be far from fulfilling all of the conditions.

THE GIBBS NITRATE PROCESS.

A pamphlet has been published in Valparaiso describing the Gibbs process for recovering nitrate of soda from the nitrate deposits of Chile. This pamphlet has been written by I. Berkwood Hobsbawn and J. L. Grigioni, the two engineers who established the process for Gibbs & Co., the South American branch of Antony Gibbs & Sons, of London. The process consists of the application of the Dorr classifier and counter-current system of leaching. An experimental plant was erected in London in 1914, and this was sold to the Italian Government. The plant now described has been erected at the Celia works at Antofagasta, and has just been started. The authors commence by referring to the disadvantages of the older method of leaching the nitrate and accompanying salts from the caliche. They show how much nitrate is lost by the water not penetrating the clay and stones which constitute the lumps of the material being leached, and also how other nitrate is lost by the difficulty of extracting the solution from the fine material and slime. The filter-press has previously been applied for overcoming the latter difficulty, but it is not advisable to apply such a machine to the whole of the caliche, for this would necessitate the fine grinding of the whole of it. Moreover it is not desirable to send the whole of the caliche through filters, seeing that a large proportion



Flow-Sheet of Gibbs Nitrate Process.



Diagrammatic Elevation of Gibbs Plant.

of the material is barren mineral matter. The Gibbs process employs comparatively coarse grinding, the early elimination of the coarse earthy matter, the recovery of most of the nitrate solution by counter-current washing, and of that in the finest slime by filter-pressing. As the authors say, the process aims at a disintegration of the conglomerate and not a grinding of the material. This disintegration is brought about, together with the dissolution of the soluble binding agents, by causing the solid lumps to rub against each other in a slowly revolving mill while in the presence of the solvent, which is a weak solution of nitrate. The quantity and temperature of the solution fed in is decided by the strength of the liquor desired. A resulting liquor containing about 450 grammes of nitrate per litre and of a temperature of about 50°C. is considered the most suitable and economical. The issuing pulp is delivered to the classifier system, where the slime is first separated, and the sand treated in three other classifiers on the counter-current system, while the slime is thickened and sent to a filter. The accompanying illustrations give a flow-sheet and a diagram of the cycle of operations. The caliche is crushed to ½ in., and delivered to the disintegrating mill M together with the liquor from the second classifier C_2. The disintegrated material goes to the first classifier C_1, where the slime is separated. The slime goes to a thickening tank T_1, from which the thickened slime goes to an Oliver filter F. The overflow from T_1 goes to the first classifier C_1. The solution removed in the filter goes through the clarifier B to the evaporating plant, and some back to the thickener. The wash water from the filter goes to the 3rd classifier. The sandy material from the first classifier goes through the classifiers C_2, C_3, and C_4, where it is treated on the counter-current system, the clear wash water being introduced in C_4.

STELLITE, THE COBALT-CHROMIUM ALLOY.

At the September meeting of the American Institute of Metals, Ellwood Haynes, of Kokomo, Indiana, read a paper giving an outline of his work in connection with the "stellite" alloys. These alloys consist of cobalt and chromium with small admixtures of tungsten or similar metal. They are proof against the attack of organic acids and similar corrosive substances, and they are applicable to lathe work as rivals to high-speed steel. We quote from Mr. Haynes' paper at some length, as our readers will desire to hear the inventor's claims and arguments.

In 1887 Mr. Haynes made some experiments with a view to obtaining an alloy which would resist the oxidizing influences of the atmosphere, and at the same time take a good cutting edge. Generally speaking, he found that alloys containing copper, including the bronzes, gave little promise in either direction. He found that all alloys containing any considerable amount of copper were soon affected by the sulphur gases, particularly in the presence of moisture. He then sought to alloy nickel with aluminium and other metals. In 1892, he made an alloy of nickel and tungsten, containing about 30% of the latter metal, by fusing pure metallic nickel with powdered tungsten in a crucible made of a mixture of pure alumina and magnesia. The alloy produced had considerable malleability, and when polished, showed a good lustre, but it tarnished slowly in the atmosphere of the chemical laboratory. In 1899 he produced an alloy of nickel and chromium, containing about 10 or 12% of the latter metal. This alloy was made by heating a mixture of the oxides of nickel and chromium with pure powdered aluminium. A compact button was obtained, which, when polished, showed a fine lustre. It possessed also considerable malleability when cold, but could not be worked hot. When brightly polished and placed in nitric acid it showed no change whatever, its surface remaining brilliant even after long exposure to the acid. In fact boiling nitric acid has little or no effect on an alloy of this character. Later he produced alloys of these two metals containing as much as 50% chromium.

Shortly after producing the nickel-chromium alloy, he produced an alloy of cobalt and chromium in the same manner. Owing, however, to the larger oxygen content of the cobalt oxide, the action in the latter case was more violent, and only a few small pellets of the reduced alloy could be obtained. These pellets were very hard, almost completely resisting the file, but they were distinctly malleable when cold, and decidedly malleable when hot. They resisted nitric acid as effectively as the nickel alloy, and gave promise of making good non-oxidizable edge tools, such as table and pocket-knives. They not only took a high polish, but retained their brilliant lustre under all atmospheric conditions. Prolonged exposure tests were made on them, and in 1907 patents were taken out on both alloys. A paper describing both the nickel-chromium and the cobalt-chromium alloys was read before the American Chemical Society, at San Francisco, in July, 1910. The cobalt-chromium alloys were found to be capable of manipulation to a limited degree at a bright red heat, and have been worked into table-knife blades, pocket knife blades, spatulas, surgical instruments, and many other useful forms. To these alloys the name "stellite" has been given, named from the Latin word, stella, a star, because when once polished, they always retain their lustre.

The alloys ot cobalt and chromium possess the following properties: (1). They melt at a temperature of about 2,800° to 2,900°F. (2). They can be cast into bars or other forms, preferably in a metal or graphite mould. (3). They are almost file-hard. (4). They are slightly malleable when cold. (5). They are distinctly malleable at a bright red heat, and may be forged into table-knife blades and other useful forms. (6). They retain their lustre under practically all atmospheric conditions. (7). They are practically immune to all organic acids, such as vinegar, lemon juice, malic acid, etc. (8). Instruments made of them take a good cutting edge, and table-knives made of them retain their lustre and colour for years without repolishing. (9). The colour and lustre of the alloy leave little to be desired. While the alloy is not quite as white as silver, it far excels it in permanent lustre and durability. (10). The alloy cannot be hardened by heating to redness and quenching in water or other medium, though its elastic limit may be raised considerably by hammering, while its modulus of elasticity is greater than that of steel. This latter characteristic permits of the making of comparatively thin table-knife blades of the alloy without too much impairing their stiffness. The elastic limit of these alloys is about 85,000 lb., and their tensile strength about 110,000 lb., though these properties vary with the composition and treatment of the alloy.

Soon after reducing the binary alloy to a practical form, Mr. Haynes began experimenting to determine the effect of introducing tungsten or molybdenum into the alloy. He found that either or both of the above metals, when introduced into the binary alloy, increased its hardness to a marked degree, rendering it at the same time less malleable and more brittle. By introducing a sufficient amount of tungsten, say 8% to 20%, ternary alloys were made that were so hard that they would readily scratch glass, or even quartz. These were introduced into the machine shop as lathe tools, and soon showed remarkable superiority over the high-speed steels. The first alloys produced for commercial purposes were brittle, but notwithstanding this fact, they were effective if carefully handled. Afterward, alloys almost equally hard, but much stronger, were produced, and, later, standard compositions were established, which soon won their way into machine shops on account of their superior advantage in the turning of duplicate parts.

When the stellite tools were first introduced into the machine shop, they were employed principally on cast iron, and showed such good results in the cutting of this material that they speedily won their way, particularly into the larger establishments which were engaged in the manufacture of large numbers of duplicate parts, such as pistons, cylinders, fly-wheels, reducing gears, etc. It has been found since that when the tools were properly ground, they show an advantage over steel tools in the turning of practically every grade of steel. It is a remarkable fact that the edge strength of the stellite tool increases as the temperature rises, becoming maximum at pretty near a dull red heat, and yet retaining sufficient hardness to enable it to cut ordinary steel without undue wear. If, on the other hand, the steel to be turned is very hard, the wear may become excessive before the tool reaches a red heat, but it is claimed that the turning speed of the stellite tool, even under such unfavourable conditions, is always from 10% to 50% greater than that of the best steel tool.

It is well to state here that the basis of comparisons between stellite and high-speed steel tools is not the same as that between one steel tool and another. It is a well known fact that, if one steel is to be pitted against another, a certain definite speed, feed, and depth of cut are first established for one of the tools, and the tool is then used until it becomes sufficiently dull to require regrinding. The competing tool is then introduced and allowed to run until it becomes dulled. The basis comparison is then the *relative length of time* the tools ran. Stellite seldom if ever competes under these conditions, since in order that it may work to the best advantage, the speed of the lathe must be increased while other conditions (namely, feed and depth of cut) may or may not be changed. The basis of comparison then becomes the *relative number of pieces turned* in a given time, irrespective of the number of grinds required by the tool. It is only fair, however, that the tool cost per unit of work shall be added to the cost per piece in each case. The tool cost, however, of either steel or stellite, particularly if the tools are of small section, say ½ in. square or under, is usually of small moment when compared with the increase in production effected by stellite tools. Some of the users of high-speed steel tools insist, however, on simply an endurance test, measuring the advantage or disadvantage of either tool by the number of grindings required for a given amount of work. If such a condition is insisted upon, then it is only fair that it shall be made on the stellite basis, that is, at the proper speed, feed, and depth of cut capable of being maintained by a stellite tool. A test of this kind was recently made under the following conditions:

Material turned	High carbon steel, un-annealed
Depth of cut	1/32 in.
Feed	0·036 in.
Speed	140 feet per minute

Under the above conditions it was found that the steel tool had to be ground 100 times for every grinding of the stellite tool. In fact, it was utterly impracticable to turn the steel at this speed with a steel tool, as it would only cut long enough to become heated, and would then fail, while the stellite tool would readily turn from 100 to 150 times as great a distance without grinding. This test is manifestly unfair to the steel tool, because at a lower speed the steel tool would cut continuously, or at least as long as the stellite tool. A test at slow speed, suitable for the steel tool, however, would manifestly be just as unfair to the stellite tool. In other words, each tool should be used under such conditions as would enable it to do its best work.

Chemical spatulas made from the stellite are satisfactory in the laboratory as they are strong and highly elastic, but they must not be exposed to hydrochloric, hydrofluoric, or sulphuric acids, or mixtures of them. They are, however, immune to nitric acid, as well as to ordinary solutions of the organic acids and to boiling solutions of the caustic alkalies. They are likewise immune to the atmosphere of the chemical laboratory, and with the above precautions, will retain their colour indefinitely in the hands of the chemist. Evaporating dishes made of stellite are useful for boiling solutions of the caustic alkalies and for the preparation of nearly all neutral chemical salts. They are exceedingly strong, and are not injured by sudden heating or cooling, or by dropping on the floor. They also receive an excellent polish, which renders it easy to remove salts or compounds which have been evaporated to dryness.

When stellite is heated to dull redness it becomes covered with a film of oxide which gradually changes to a deep blue-black colour. After this film of oxide has become established, it is not easily disturbed, and the metal does not undergo further change of any consequence, even when heated to 1,000°C., and maintained at this temperature for an indefinite period. Vessels made of stellite are therefore useful for annealing or carbonizing purposes, as they do not readily take up carbon, and are practically immune to further oxidation. They show no tendency to scale, even when they are maintained at a bright red heat for an indefinite period.

NORTHERN MANITOBA AS A MINING COUNTRY.

The existence of profitable ore deposits in Manitoba has recently been proved. In our issue of November a year ago we gave details of the gold-copper deposits at Flin-Flon, Schist, and Herb Lakes, near The Pas station on the Canadian Northern Railway, and since then we have published reports of the progress of their development. These discoveries have drawn attention to a province of the Dominion that has been generally neglected as a possible mineral region. Mr. J. B. Tyrrell has written an interesting account of the province, giving both reminiscences and opinions as to the future, in the *Manitoba Public Service Bulletin*. We quote herewith from this article.

Those who have made a study of Canada's mineral resources and who believe that the country has vast reserves of mineral wealth stored away for the use of this and future generations, and that she has just begun to distribute a little of this wealth to those who search for it, know well that the old Keewatin Greenstones, together with the conglomerates, porphyries, and diabases which are usually associated with them, are the rocks favourable to the occurrence of the precious and semi-precious metals that now form such a large proportion of the mineral production of the Dominion. Last year the Canadian production of gold, silver, copper, nickel, cobalt, molybdenum, asbestos, etc., all of which are largely derived from these old Greenstones and their associated rocks, had a value of about one hundred and five million dollars. Iron, zinc, lead, and many of the rare metals and minerals may also be expected to contribute their quota to the riches to be derived from these rocks,

A large area of the Greenstones, etc., was shown to exist in Northern Manitoba as a result of an exploration which Mr. Tyrrell conducted for the Dominion Government about twenty years ago. At that time this region had not been incorporated into the Province of Manitoba, but was part of the unorganized district of Saskatchewan under the direct jurisdiction of the Government of the Dominion of Canada. None of the ordinary means of modern transportation had approached the country. The nearest railroad was the Regina and Long Lake Branch of the Canadian Pacific Railway, now a branch of the Canadian Northern Railway, to Prince Albert; and the nearest steamboat route was on Lake Winnipeg from Selkirk to Grand Rapids or Norway House. From any of these places the country could be entered by canoes, and travel was confined to the many beautiful streams and lakes scattered through it. In the prairie country to the south and south-west surveyors had been working for a number of years, and had made fairly accurate surveys on an extensive scale, but these surveys had not been extended into this country, and consequently there were no modern maps of the canoe routes that the party were obliged to use through it. The only map that was serviceable was that made by David Thompson, one of the fur-traders of the old North-West Company, about 100 years before the date of the visit.

The district was one in which Indian hunters and fur-traders of the Hudson's Bay Company were still in undisputed possession. The positions of the trading posts, and the lengths and courses of the canoe routes between them, were known only to the traders themselves and to their Indian guides. It must not be supposed that the advent of a Government exploring party, whose duty it was to survey the routes of travel throughout the country, to make and publish maps of all these routes, and to investigate and report on all natural resources, but more especially on the mineral and agricultural possibilities of wealth, would be hailed with any enthusiasm by fur-traders, who had been so long in undisputed possession of the country that they had come to believe that they owned it. Most of them undoubtedly entertained the mistaken idea, which until recently was shared by many men calling themselves educated throughout the Dominion, that the country would never support anything but fur-bearing animals and that the pelt of these animals was its only possible wealth. Nevertheless, these lonely traders were very human and received the party with great kindness. The party that summer consisted of Mr. Tyrrell, Roderick Thomas, and John Harper, the latter being two men who had been with Mr. Tyrrell through the Barren Lands in 1894, together with a couple of local Indians on parts of the journey. They travelled down Lake Winnipeg to Horse Island on the old steamer "City of Selkirk," whence the tug "Angler" took them to Eagle Island, and from there they went in their own canoe along the north side of Lake Winnipeg, and through Playgreen Lake to Norway House. From there, after exploring Wolf and Pine Rivers, they descended Nelson River to Cross Portage, which they had previously reached on their overland route from Fort Churchill to Winnipeg in December, 1894. From there they surveyed the streams and lakes westward as far as Nelson House on Three Pcint Lake, where they had the pleasure of staying a little while with Mr. and Mrs. Stout, the Hudson's Bay Company's trader and his wife, and also with Mr. and Mrs. Gaudin, the Methodist Missionaries at the same place. From there they returned down Burntwood River and surveyed the route by Grass River aud Cranberry Portage to Cumberland House, stopping for a little while with Mr. George Cowan, who was then building a house on Reed Lake.

While they were surveying the rivers they were also examining the rocks on their banks, and as a result of the examination they determined the existence of the belt of Greenstones mentioned above, which was then shown to extend from Wekusko Lake on the east, westward to Athapapuskow Lake and beyond. Incidentally they determined the existence of an extensive area of rich alluvial land in the valley of Grass River and its vicinity. It must not be considered, however, that the sceptics as to the prospective value of this Northern wilderness are all located outside of the Province of Manitoba, for when Mr. Tyrrell stated that there was much good rich agricultural land in that northern part of the Province there was a chorus of protests against such "nonsense," as may be verified by reference to the Winnipeg papers of the autumn of 1896.

Shortly after making the examination of the region Mr. Tyrrell resigned from the service of the Dominion Government and began private practice as a mining engineer, and it was not until the autumn of 1916, twenty years after his previous visit, that he had the opportunity of revisiting the country, in part in a commodious private car on the Hudson Bay Railway, and in part in canoes, as on the occasion of his previous visit. The country is in much the same condition now as it was then, but there is now a thriving town on the bank of the Saskatchewan River at The Pas, where there was only a small but historic Indian Mission. A splendid modern steel bridge spans the river just opposite the town, and from it a new line of railway stretches off into the wilderness to the north, destined within a short time to bring this portion of the great inland Province of Manitoba to within a day's journey of the sea-coast. Deposits of minerals have been discovered by adventurous prospectors on the shores of some of the beautiful lakes that up to a year ago had never known a visitor other than the wild animals of the Canadian forests and the Indian hunters who followed them.

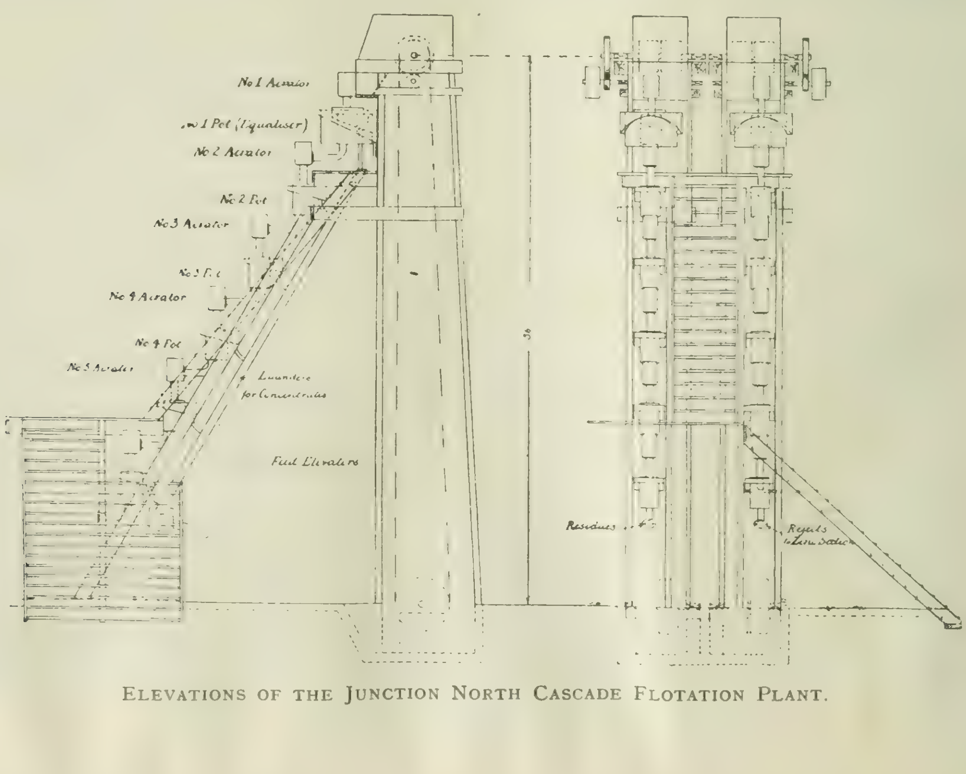
Through the kindness of the Honourable A. B. Hudson and Mr. J. A. Campbell, Mr. Tyrrell was invited to join their party and go northward to the end of the track on the Hudson Bay Railroad, which was then 295 miles from The Pas. The weather was pleasant and the journey was particularly enjoyable, as it gave him an opportunity of seeing the country away from the streams and under quite different conditions from those under which he had seen it twenty years before. For a hundred miles north of The Pas the country is almost level, and the soil is often quite thin, being underlain by flat-lying beds of limestone. Thence onward almost to the end of the track the land is generally rolling and sparsely wooded with spruce and poplar. The underlying rock is chiefly granite, but it is usually covered with a considerable thickness, perhaps thirty feet or more, of stratified clay which looks as if it would yield abundant crops to the farmer if it were properly cultivated. Very few cuttings on the railroad go down into the granite rock, but there are a number which show excellent sections of this rich stratified soil. Not many deposits of valuable minerals have been discovered along the line of the railroad itself, but Herb or Wekusko Lake is only 8 or 9 miles west of the railway, and is being connected with one of the stations by a good wagon road. On its shore a number of gold-bearing veins have already been found and are being actively developed. As the country is now definitely known to contain gold, search for rich veins will doubtless be continued more energetically as more prospectors learn to know the country.

After having spent four or five days along the line of this new railway, Mr. Tyrrell turned westward and travelled up the Saskatchewan River to Cumberland House, from which place the new copper mines on Schist and Flin-Flon Lakes were visited. Here again the miners have broken into the northern Canadian wilderness and have discovered rich bodies of ore which may be expected to yield more wealth to the country in a very few years than furs have yielded ever since it was first visited by white men. The ore already discovered is situated about 100 miles from the railway and more or less remote from any regular line of transportation, but, nevertheless, it is not improbable that it may need to have a railway built to it for its own use, and it would be an interesting comment on the construction of the Hudson Bay Railway if it were found necessary to build branch lines from that railway to develop the local resources of the country before the main line itself should be completed.

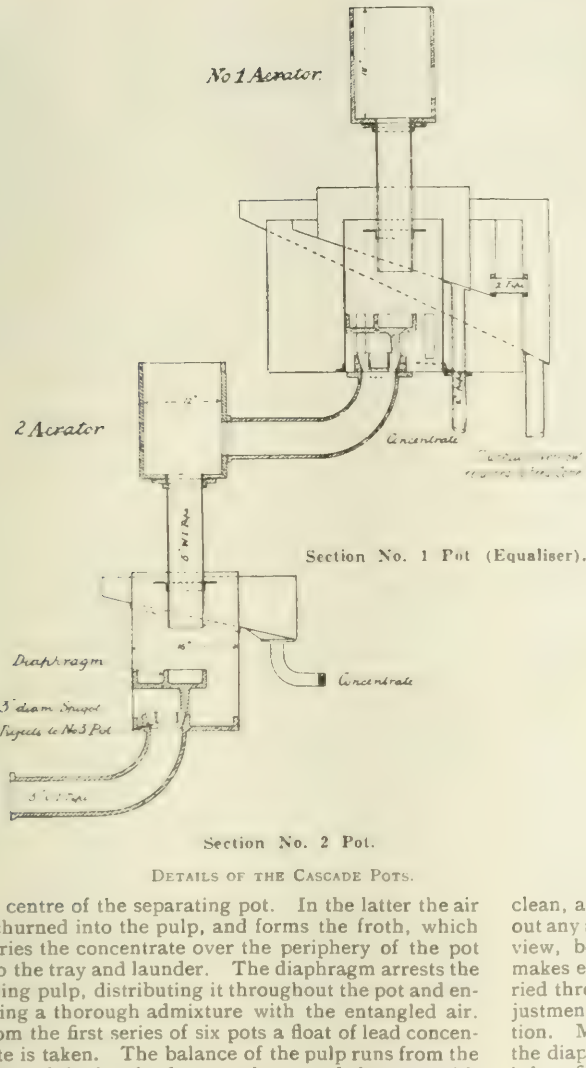
The people of Canada have begun to realize that there is in Northern Manitoba a great country which is worth exploring and developing for the natural resources which it contains. The country is just at the dawn of its development, and in the next twenty years it will doubtless progress at a rate quite unknown in the past. Mr. Tyrrell confidently expects that twenty years hence the region will possess towns and villages which will be centres of profitable mining industries, and also a prosperous farming community which will not only be raising a food supply adequate for the use of the country itself, but also for export to assist in feeding those who live in cities or districts less favourably situated.

CASCADE FLOTATION AT JUNCTION NORTH.

In the *Mining and Engineering Review* for August, T. H. Palmer, general manager of the Junction North mine, Broken Hill, describes the Seale-Shellshear cascade flotation plant designed and developed at that mine. The inventors, H. V. Seale and Wilton Shellshear, were engineers at the mine, and they developed the cascade method, on the lines outlined in an editorial in our August issue. A plant to treat 3,000 tons per week was erected just before the war, and it ran experimentally for a year. The plant consists of two sections, each of six pots, for lead and zinc respectively. Each six pots are placed in series, *en echelon* one below the other. The pulp is delivered from an elevator into the top pot and falls through the set by gravity. The pots are cylindrical in shape, 16 in. in diameter and 24 in. high. Immediately above each pot there is an aerator. This consists of an open receiving box, 12 in. square, which is fed by a 5 in. bend leading from a 3 in. spigot in the bottom of the pot above. The square shape of the aerator causes the pulp to swirl and entangle a quantity of air with it, as it drops into a 5 in. vertical pipe down to a diaphragm splash-plate in



Elevations of the Junction North Cascade Flotation Plant.



Section No. 1 Pot (Equaliser).

Section No. 2 Pot.

DETAILS OF THE CASCADE POTS.

the centre of the separating pot. In the latter the air is churned into the pulp, and forms the froth, which carries the concentrate over the periphery of the pot into the tray and launder. The diaphragm arrests the falling pulp, distributing it throughout the pot and ensuring a thorough admixture with the entangled air. From the first series of six pots a float of lead concentrate is taken. The balance of the pulp runs from the spigot of the last lead pot to the second elevator, with acid and oil additions, for delivery to the second series of zinc pots, which operate in a similar manner. The first or top pot of each section has an additional special function to perform as an equalizer. Its special object is to balance any irregularities in the flow of the feed from the elevator, and to ensure a constant head for its own discharged spigot, so that this will continually deliver the same quantity of feed to the second pot, which will then be maintained to each successive pot throughout the series. It has four slots cut in its side near the bottom, which open into a surrounding cylindrical pot, 40 in. in diameter, provided with two annular overflow rings, and set at a very slightly lower height than the concentrate overflow ring. Surplus liquor overflows from it to the feed-dewatering system. By this contrivance the first pot has very little disturbance, and the following pots have none at all; the whole system is entirely self-operating and needs no attention. All pots have the same sized spigot, and the height of each pot is reduced fractionally to allow for the quantity of concentrate taken off above it; so all the pots are kept full, and the froth continuously overflows from each without any hand regulation, or danger of excess overflows of liquor or gangue to spoil the grade of the concentrate.

Mr. Palmer, in his article, refers to previous publications relating to the Seale-Shellshear process as subsequently adopted by the Sulphide Corporation. The article to which reference is made was published in the issue of the *Mining and Engineering Review* for June. Unfortunately copies of this issue coming to this country were lost owing, as the official reports say, "to enemy action." Nevertheless some of Mr. Palmer's comments on that article are easily understood. He says that the plant at the Central mine is somewhat similar to one of the many machines which was tried and discarded in the development of the process, and that this lacks several of the features which the inventors regard as first principles of the process. The Junction North cylindrical pots, having the concentrate overflow all round the periphery, permit of very short travel and rapid take-off of the aerated particles, which is essential in the selection of the sulphide of lead by a hot or cold water process, particularly when treating sandy material. For this reason Mr. Palmer considers the Central mine design is a retrograde step. To overcome the inequality of volumes of feed from moment to moment it is necessary to have an equalizing pot at the head of the series, and to provide that surplus of liquor be returned to the feed-de-watering system. The first pot is somewhat disturbed in this way and the concentrate is liable to be fouled by admixture of gangue, but each of the following pots in the series works uniformly and the concentrate is clean, and the whole series works automatically without any attention whatever. This is, in Mr. Palmer's view, better than the Central mine design, which makes each pot an equalizer with the disturbance carried through to every pot in the series; the hand adjustment is not adequate and requires constant attention. Mr. Palmer does not agree with the absence of the diaphragm in the Central mine design, as he finds it beneficial in smashing up and thoroughly aerating the pulp as it falls with its entangled air into the treatment pot.

Alluvial Tin Mining. — In our issue for March last we quoted remarks made by J. Malcolm Newman on a paper read by A. C. Perkins on bucket-dredging for tin. Mr. Newman is not enamoured with the bucket-dredge as a tin saver nor does he worship the fetish of low costs. In reply to our invitation to contribute further to the subject, he has sent us copies of reports made to the directors of Larut Tin Dredging Limited, an Australian company operating in Perak, Federated Malay States. He is now on active service and therefore unable to find time to treat the subject more fully. His remarks relate partly to bore-hole results and partly to dredging.

As regards sampling the ground, two features of the methods of valuation require noting, as they have a important bearing on the probable ultimate profit to be derived from a property. The first of these is the method of boring usually adopted in Malaya. By it the holes are bored by sand-pumping alone, with the result that a smaller proportion of core is obtained from the richer stony karang than from the other materials passed through. Another result of the use of the sand pump from start to finish of a hole is that it may give a misleading idea of the position of the bottom of the pay ground by salting some feet of the bottom. In this way the payable ground may be reported to be deeper than it actually is. In other words this method is liable to report a given weight of tin as distributed over a bigger depth than that in which it will be mined by a dredge. For these two reasons boring results may be considerably lower than actual tin contents. A third undesirable result of the boring method described is its failure to obtain exact information as to the nature of the material passed through. This particularly applies to ground containing masses or bands of clay. In the state in which the material reaches the surface in the sand pump very little idea can be got as to its friability, with the result that it may be only after dredging is started that the clayey material is discovered. Another feature of ground valuation requiring comment is the method usually adopted in Malaya of putting boring results on plans. By this system depths, profits, and values are averaged over large areas instead of those areas being divided into series of blocks of analogous depths, profits, and values. This averaging over large areas results frequently in a misstatement of the position, and leads to wrong conclusions. In the case of Larut, he found that about 28 acres of the ground originally included in the prospectus might reasonably be considered unprofitable, part of it being shallow and all of it being of low value; while another block formerly rejected but now acquired, is profitable, for, although it as a whole averages rather low, it can be divided roughly into two halves, that adjoining the other payable ground being well within the payable margin and the outside half poor and shallower.

With regard to the dredging practice, Mr. Newman is of opinion that generally speaking in Malaya the digging capacity of bucket-dredges is much beyond the treatment facilities. This probably results from a lack of appreciation of the particular conditions prevailing, namely, the fairly even distribution of the tin from the grass roots to the bottom. Where, in other places, as at Tongkah for instance, by far the greater part of the material to be handled is barren overburden, obviously the problem is largely a digging one; but where, as at Taiping, almost any one bucketful of material may be the richest in the property, it is equally obvious that the principal consideration is to properly treat the whole of the material dug. As a result of his inquiries before leaving Australia for Malaya, he came to the conclusion that the Larut company's dredge as designed did not contain sufficient sluicing area as compared with its digging capacity. The construction of the dredge was therefore suspended pending his inquiries on the spot. Good Australian practice in tin-sluicing by gravel-pumping provides about 1 ft. width of sluice-box for every 2 yards per hour of sand to be treated. When this is compared with 5 to 7 yards per foot width frequently obtaining in Malayan bucket-dredges, there would be some doubt as to the suitability of the plant provided. Further, in a gravel-pumping plant the tin-bearing material is usually thoroughly disintegrated, whereas the ordinary bucket-dredge has very little disintegrating effect. This is particularly obvious to an observer in Malaya, and it is his personal opinion that the recoveries of actual tin in the ground on bucket-dredging properties in the Federated Malay States are low, being seldom more than 70%. With the above facts in view, and taking specially into consideration the physical conditions existing on the Larut property, certain alterations were made to the dredge while under construction in Melbourne. Additions were made to the pontoons to carry a considerably increased area of sluice-boxes, and provision was made to disintegrate and treat the material which escapes through the screen untreated. Alterations were also made in the save-all treatment. A second series of sluice-boxes is arranged below the others, and over them is passed material which formerly went straight to the dump. This is now disintegrated after it leaves the screen, and it is drawn from a sump through a gravel-pump to the head of the lower boxes.

World's Silver Production. — The *Engineering and Mining Journal* for October 20 publishes an estimate of the silver production of the world during 1916. This is given in Table I. herewith. Table II. contains figures for the totals during the last ten years.

TABLE I.—SILVER PRODUCTION OF THE WORLD.
In Troy Ounces, Fine Silver.

	1915	1916
United States	74,961,075	74,414,802
Canada	26,625,960	25,669,172
Mexico	39,570,151	38,250,000
Central America	2,920,496	3,127,500
South America	13,687,464	14,650,000
Total America	157,765,146	156,111,474
British India	284,875	262,500
China	18,230	21,500
Japan	5,079,552	5,194,800
Chosen	21,876	33,900
Dutch East Indies, Indo-China, etc.	48,032	56,650
Total Asia and Oceanica	5,452,565	5,569,350
Transvaal	996,379	954,600
Rhodesia	185,233	171,200
Congo and other Africa	4,770	6,500
Total Africa	1,186,382	1,132,300
Europe	9,276,930	8,954,400
Australasia	4,295,757	4,165,500
Total for the World	177,976,780	175,933,024

TABLE II.—SILVER PRODUCTION FOR 10 YEARS.
In Troy Ounces of Fine Silver.

1907	183,446,268	1912	250,915,189
1908	212,585,573	1913	223,582,706
1909	227,289,440	1914	160,626,019
1910	240,213,965	1915	177,976,780
1911	254,201,239	1916	175,933,024

Flotation at Mount Lyell. — The *Mining and Engineering Review* for September describes the flotation plant erected at the Mount Lyell copper mine, Tasmania, for the purpose of treating the ore from Comstock section of the property. The ore contains chalcopyrite and pyrite finely disseminated in a schistose gangue. The average content is about 3% copper, 0·2 oz. silver, and about 0·5 dwt. gold. The flotation plant was started on February 17, 1916, and the total ore treated up to March 31, 1917, was 17,027 tons, of which 3,530 tons was low-grade ore from the North Lyell mine, of the same assay-value as the Comstock ore. The ore is first reduced in a jaw crusher to 2 in. It is then sent to submerged shaking screens of $\frac{1}{2}$ inch aperture. The oversize from the screens passes through two sets of May crushing rolls and back to the screens. The material passing through the screens is delivered into a diaphragm cone classifier, 5 ft. in diameter by 6 ft. 6 in. deep, with a diaphragm $6\frac{1}{2}$ in. in diameter near the bottom, leaving $1\frac{1}{2}$ in. annular opening. The slime overflows to two Dorr thickeners, 20 ft. in diameter and 10 ft. deep. The bottom discharge from the classifier is divided between two tube-mills 16 ft. 5 in. long and 5 ft. diameter, revolving at the rate of 29 r.p.m. The discharge from the tube-mill joins the Dorr thickener discharge, and is elevated into Minerals Separation flotation boxes of standard size, having 18 in. impellers revolving at the rate of 320 r.p.m. There are a series of 12 mixing boxes with corresponding spitz or flotation boxes. Eucalyptus oil is added sometimes to the mixing boxes, but usually to the tube-mills. The consumption of oil is slightly less than ¾ lb. to the ton of ore treated. Oil costs about 8d. per lb. The tailing from the Minerals Separation boxes flows direct to the dam. No return water can be used on account of the excessive sliming of the gangue in the ore. The fine concentrate is at present being re-treated in a simple apparatus designed by the local staff, with considerable improvement in grade. The final concentrate is elevated into steel settling tanks 20 ft. diameter and 8 ft. deep, provided with filter bottoms and with vacuum pumps attached. The concentrate is sent from these tanks in trucks to the sintering plant. An Oliver filter is being erected for the continuous filtering of the concentrate. The plant was designed under the supervision of L. V. Waterhouse, the mill superintendent.

Making Sodium Cyanide. — In the *Mining and Scientific Press* for October 13, G. H. Clevenger describes his experiments with the Bucher process for making sodium cyanide, and his proposed method of applying it at metallurgical plants. The inventor of the process is John S. Bucher, and it was described in the *Journal of Industrial and Engineering Chemistry* for March last. By this method, iron filings, crushed coke, and soda ash are mixed and made into small briquettes. These are charged into iron pipes a few inches in diameter and about 6 ft. long. The pipes are placed in a furnace and heated to 1,000°C., and then a current of nitrogen, or more conveniently producer gas high in nitrogen, is passed through the pipes. The result is the formation of a certain amount of sodium cyanide, which is removed from the briquettes by subsequent leaching. Mr. Clevenger proposes that the briquettes, when made at the mine, should be leached with the barren solution from the cyanide plant.

Cock's Pioneer.—In the *Mining and Engineering Review* for September, Arthur H. P. Moline describes the pump-dredging operations for gold and tin at Cock's Pioneer mine, Victoria. The article contains details additional to those given in his paper printed in the July issue of the Magazine.

Flotation in Missouri.—In the *Mining and Scientific Press* for October 20, C. A. Wright describes the flotation of lead and zinc minerals in the Joplin district.

Flotation Oils.—In the *Bulletins* of the Canadian Mining Institute for October and November, R. E. Gilmore and C. S. Parsons write on Canadian Wood Oils for Flotation.

Concentration in Missouri.—The October *Bulletin* of the American Institute of Mining Engineers contains papers by A. P. Watt and C. A. Wright respectively on lead and zinc concentration practice in Missouri.

Glass Surfaces in Tin Concentration.—At the November meeting of the Institution of Mining and Metallurgy, a paper by H. A. Lewis, of the Porco tin mine, Bolivia, was presented, dealing with comparative results obtained with glass and other surfaces on concentrating tables.

Leaching with Ammonia.—In the *Engineering and Mining Journal* for November 3, H. M. Lawrence describes the plant for leaching copper tailing with ammonia at the Kennecott mine, Alaska.

Metallurgy of Copper. — Professor H. C. H. Carpenter delivers a series of Cantor Lectures before the Royal Society of Arts on December 3, 10, and 17 on Progress in the Metallurgy of Copper.

Copper Converting.—In the *Engineering and Mining Journal* for October 20, Mr. W. Krecji gives a history of the development of copper converting in America.

Smelting at Anyox.—In the *Engineering and Mining Journal* for October 13 and 20, W. A. Williams describes the mine and copper-smelting works of the Granby Consolidated Co., at Anyox, British Columbia.

The Partridge Smelting Furnace.—In the November *Bulletin* of the Canadian Mining Institute, A. R. Partridge describes the latest form of his smelting furnace, suitable for work on a small scale at prospects or mines. We gave particulars of an earlier form of this furnace in our issue of April, 1910.

Clays for Zinc Retorts.—A paper by C. P. Fiske, in the October *Bulletin* of the American Institute of Mining Engineers, describes the clays used in the manufacture of retorts at the Palmerton zinc furnaces and the practice in making the retorts and other vessels.

Zinc Refining.—L. E. Wemple writes on Zinc Refining in a paper issued in the November *Bulletin* of the American Institute of Mining Engineers. This paper discusses American practice as developed during the last few years for refining low qualities of zinc.

Arresting Fume.—In the November *Bulletin* of the American Institute of Mining Engineers, G. S. Brooks and L. G. Duncan describe the filters for catching dust and fume at the Depue works of the Mineral Point Zinc Company.

Electrolytic Antimony.—In the *Engineering and Mining Journal* for November 3, W. A. Burr describes a method of treating antimony ores by leaching with caustic soda in a salt solution and electrolysing.

Titanium. —The *Journals* of the Franklin Institute for October and November contain an elaborate paper on the Metallurgy of Titanium, by Robert J. Anderson.

Bone-Ash Cupels.—The November *Bulletin* of the American Institute of Mining Engineers contains a paper by F. P. Dewey describing researches relating to the absorption of precious metals in bone-ash cupels.

Oil in the British Isles. —At the meeting of the Institution of Petroleum Technologists held on November 20, W. H. Dalton read a paper on the Oil Prospects of the British Isles. Mr. Dalton is a pessimist on this subject, thus forming a contrast to Mr. Forbes Leslie, whose papers we quoted in the issues of October 1916 and February 1917.

Petroleum in South America.—In a paper contained in the October *Bulletin* of the American Institute of Mining Engineers, F. C. Clapp gives a review of present knowledge regarding the Petroleum Resources of South America.

Coal Production. — Professor Henry Louis read a paper on the Economics of Coal Production before the London Section of the Society of Chemical Industry on December 3.

Sudbury Ores.—*Economic Geology* for August contains two papers on magmatic ore-bodies such as those at Sudbury, Ontario, one by A. M. Bateman reviewing present theories of their origin, and the other by A. P. Coleman giving recent evidence in favour of magmatic segregation.

Nickel in Queensland.—The *Queensland Government Mining Journal* for August contains the first part of a paper by B. Dunstan, Chief Government Geologist, on Nickel, its Occurrence, Uses, and Metallurgy, with special reference to the Queensland deposits. These deposits are in the Kilkivan district, and are found also at the Hector mine near Rockhampton.

Lateritic Ore Deposits.—A paper recently presented by Willet G. Miller to the Royal Society of Canada discusses lateritic ore deposits, with comments on the nature of laterites in general. In particular he describes the nickeliferous deposits of New Caledonia.

Croydon Goldfield. — The *Queensland Government Mining Journal* for August contains an article on the progress of work at Iguana Consols. A shaft is being sunk here to test the deposit at depth, part of the capital being provided by the Government.

The Empire's Mineral Resources.—Dr. J. S. Flett gave a series of Swiney Lectures before the Royal Society of Arts during November and December on the Mineral Resources of the British Empire.

RECENT PATENTS PUBLISHED.

13,979 of 1916 (101,870). V. VINCENT, Quimper, France. Production of iodine from sea-weed, by treating with sulphate of alumina, treating the resulting alkaline iodine solution with sulphate of copper and sulphurous acid or sulphites, separating the cuprous iodide by centrifugal action, and recovering the iodine by heating the cuprous iodide in retorts together with an oxidizing agent.

16,414 of 1916 (102,377). P. C. H. WEST, London. Method of producing basic lead sulphate from lead sulphide ore.

15,471 of 1916 (102,059). NORSKE AKTIESELSKAB, Christiania, Norway. Method of producing pure titanium oxide or compounds from ilmenite or other titanium-iron minerals.

2,701 of 1917 (104,678). M. V. GARIN, Paris. Process for the electro-deposition of copper and nickel from low-grade solutions.

13,934 of 1916 (109,996). G. H. BAILEY, G. W. A. FOSTER, and the BRITISH ALUMINIUM CO., London. Method of producing anhydrous magnesium chloride.

13,958 of 1916 (109,998). H. SPENCE, W. B. LLEWELLYN, and PETER SPENCE & SONS LTD., Manchester. Method of treating alunite, after ignition, with sulphurous acid solution, and producing basic sulphate of alumina and sulphate of potash.

14,415 of 1916 (110,188). A. L. BLOMFIELD, Denver, U.S.A. Apparatus for thickening pulp.

3,125 of 1917 (110,474). M. V. GARIN, Paris. Improvements in rotary cathodes for the electrolytic deposition of copper and nickel from solutions.

8,002 of 1917 (110,717). K. SUNDBERG, Guldsmedshyttan, Sweden. In flotation machines, causing a horizontal whirl by the introduction of jets of air or other gas.

NEW BOOKS

A Treatise on Mine-Surveying. By Bennett H. Brough. Fourteenth edition, 1916. Revised and enlarged by Harry Dean. Cloth, octavo, 477 pages, illustrated. Price 7s. 6d. net. London: Charles Griffin & Company.

"Brough's Mine-Surveying," as students familiarly designate it, with affection or otherwise according to their temperamental attitude toward the acquisition of knowledge, was for many years *facile princeps* in this particular field of technological literature. In recent years, however, owing to the unprecedented development of metalliferous mining in America and the Dominions, and the consequent demand for the execution of an enormous amount of important underground survey work with accuracy and despatch, instruments of improved construction adapted for quick manipulation have had to be designed, and methods of observing, recording, and calculating, both speedy and self-checking, developed, to enable mine surveyors to cope successfully with the large volume of highly expert work which they have been, and are increasingly, called upon to perform. The mine surveyor of to-day also is quite a different type of man from the rule-of-thumb technicist of yesterday. On a large mine, in addition to his ordinary routine surveying duties, he has control of the sampling operations, the valuation of the ore reserves, the preparation of statistical matter and reports relating to the work of the mine, is required to keep a close watch for and to interpret any geological happenings which may necessitate an alteration in the underground programme; and he is, or should be, a technical officer whose training entitles him to have his opinion carefully considered when new schemes of development are in the making. In view of this evolution in surveying methods and the higher standard of proficiency attained by surveyors, it is not surprising that the scientific presentation of the subject in text-books should have lagged behind the scientific application of principles in the field; and though a few praiseworthy attempts have recently been made to treat of the art of mine-surveying in the light of modern practice, the resulting works have secured only a limited measure of success when regarded either as vade-mecums or as rivals to "Brough" for the vote of the mine surveyor. Thanks to the careful revision carried out by Mr. Dean the modern spirit is fairly well incorporated in the volume under review; but it is to be regretted that he has allowed his desire to preserve the general plan of the book and as much as possible of the author's original work to stand in the way of some desirable changes.

Though the general scope of the treatise is so well known that it would be a work of supererogation to allude to it in detail, there are a few points to which attention may be drawn, in the hope that some benefit may accrue to future editions. In setting out right angles with the chain many surveyors prefer to employ the method, not given in the book, which depends upon the principle that the angle in a semi-circle is a right angle. This construction is an excellent example of the application of a geometrical truth to ordinary mundane affairs; and in this connection a summary of those Euclidian propositions which have a practical bearing on surveying would be a useful addition to the book, as it is not infrequently the case that survey problems of apparent difficulty are readily amenable to treatment by the principles enunciated by the celebrated geometrician of pre-Christian days. Under the heading of loose-needle surveying an historical sketch is given of the use of the magnetic needle, which, with other similar excursions into the past, might perhaps find a more congenial resting place in the pages of an encyclopedia. The advice to ignore the quadrant divisions and to read only the whole circle divisions of the horizontal circle is very sound; indeed the use of quadrant bearings may be looked upon nowadays as a survival of mediævalism. In the greatly improved section devoted to theodolites brief reference is made to Professor L. H. Cooke's useful paper on that much neglected subject, theodolite design, and an illustration of an instrument built on the lines recommended by him is given. Here a much fuller reference seems desirable in order that future purchasers may have clear ideas as to what constitutes a really good theodolite for underground work. In the chapter on fixed-needle surveying no mention is made of the simple graphic methods by means of which an error in the measurement of a side or an angle in a closed traverse can be located. The statement that "the effects of errors in the adjustments can be entirely eliminated in any of the methods by taking, at each station, two observations of the horizontal angle, between each of which the telescope is reversed in regard to the horizontal axis," is incorrect. Transiting does not eliminate the error in the measurement of the horizontal angle caused by a deviation from the vertical of the azimuth axis. This error is unimportant in surface work, where the telescope pointings are nearly all horizontal, but in underground work, where steeply inclined sights are common, it may become serious. For the determination of true azimuths the method of equal altitudes of the sun or a star is recommended. It is true that in the case of a star this is a very simple and accurate way of determining the true north, but on account of the long interval which must elapse between the observations it is not generally so convenient as either the observation of a circumpolar star at elongation or of extra-meridian observations of the sun or a star. In the matter of scales for plotting mine surveys it should be noted that those which introduce fathoms are becoming out of date, and that the natural scales of 1 : 500, 1 : 1,000, and so on, are now the usual thing. Rather scant notice is directed to that handy instrument the polar planimeter. It is so often an implement of mystery to novices, and so often ineptly used by survey practitioners, who ought to know better, that a fuller treatment than the one accorded to it would be a distinct benefit. The important chapter dealing with the connection of surface and underground surveys is not as helpful as it might be. The explanatory diagram accompanying the description of how to connect through a vertical shaft by means of two plumb-lines merely illustrates one method of doing it in a way likely to furnish the most inaccurate results. Neither triangle, as drawn, supports the statement that the theodolite should be placed nearly in the continuation of the base-line. It may be as well to mention here that the best practice is so to arrange the plumbing triangle that the angle subtended by the base-line is between the limits of 1 minute and 30 minutes, being preferably of a magnitude approaching the former. Again, no reference whatever is made to the beautiful plumbing method devised and developed by Mr. F. G. A. Roberts, of Johannesburg. A method which has many brilliant successes to its credit, which has been employed in South Africa for many years for plumbing vertical shafts of 4,000 ft., and which is now regarded there as the only method for transferring the meridian underground through a deep vertical shaft which can be depended upon to give accurate results, would seem to merit some recognition in any modern text-book on mine-surveying. The addition to the information given on mine plans of a description of the laying down of the graticules of the co-ordinate net, a simple operation which has to be performed with great precision, an alphabet of block letters with the relative proportions clearly indicated, and an artistic north point of easy construction, would greatly increase the practical value of the chapter. The appendix giving a selection of examination questions would have its usefulness much increased by the inclusion of examples drawn from more varied sources and having a more extended range. For an edition published in 1916 the bibliography is curiously incomplete. There is no mention of the work on mine-surveying of Trumbull, published in 1908, or of those of Durham and Leston, both published in 1913.

The book as a whole may be said to devote too much space to certain matters of special import which rarely come within the purview of the mine-surveyor, and too little or none at all to the explanation and discussion of the many essential activities, as for instance, stope measuring, by the exercise of which he is able to maintain his position on the mine. A fuller treatment of these indispensable adjuncts to the stock-in-trade of the mine surveyor would greatly strengthen the position which the book has so worthily held for three decades.

ALEX. RICHARDSON.

The Preservation of Wood By A. J. Wallis-Tayler. Price 10s. 6d. net. London: William Rider & Son, Ltd.

Geology of the Moonta and Wallaroo Mining District. By R. Lockhart Jack. This is Bulletin No. 6 of the South Australian Geological Survey.

Ferro-Uranium. Technical Paper No. 177 issued by the United States Bureau of Mines deals with the Preparation of Ferro-Uranium. The authors are H. W. Gillett and E. L. Mack.

NEW CATALOGUES.

Climax Rock-Drills. The Climax Rock-Drill & Engineering Works Ltd., of Carn Brea, Cornwall, has issued a catalogue describing the latest model of the Climax hand hammer-drill and its method of operation.

Sullivan Diamond Drills. The Sullivan Machinery Co., of Chicago (London office: Salisbury House) has issued a book dealing with the Sullivan diamond-drill, its construction and applications.

Aerial Ropeways. A new book issued by Ropeways Limited, of London, gives the latest practice in connection with the Roe system of aerial ropeways.

COMPANY REPORTS

Geevor Tin Mines.—This company was formed by Oliver Wethered in 1906, as the North Levant and Geevor, to develop tin mines adjacent to the Levant and Botallack mines, near St. Just, West Cornwall. Additional capital was raised in 1909 and 1911, on the latter occasion the name being changed. The report now issued covers the 15 months ended December 31, 1916. The share capital was then £56,000, the debentures £16,110, and loan and sundry creditors £12,909. During the period, 26,683 tons of ore was treated, for a yield of 444 tons of concentrate, being an extraction of 3·47 lb. per ton. The income from the sales was £43,350, and the working profit was £7,877. Out of the profit £2,949 was paid as interest, £1,928 was written off, and £3,000 remained as net profit, to be carried forward against a loss of £1,338 for the previous period. The report is brought up to date by a supplementary report by the manager, W. C. Williams, dated November 14. The shaft has been sunk to 789 ft. and stations for a new level are being cut. We have already referred in our columns to the work in connection with diamond-drilling and the proving thereby of the existence of parallel lodes.

Weardale Lead.—This company was formed in 1883 to work a group of lead mines in county Durham, near the head of the river Wear. The galena is found in the Carboniferous limestone, and is associated with fluor-spar. Professor Henry Louis is consulting engineer, and H. S. Willis is manager. A lengthy account of the deposits and of the company's operations was given by Professor Louis in our issue of January last. The report for the fifteen months ended September 30 shows that prosperity continues. The amount of dressed lead ore produced was 4,627 tons, and the ore smelted, including purchased ore, was 5,452 tons. The yield of pig lead was 4,358 tons. The accounts show credits of £130,140 for lead and £12,415 for fluor-spar. The net profit was £31,796, out of which £9,000 has been placed to reserve for excess profits duty, and

£19,584 has been distributed as dividend, being at the rate of 20% for the 15 months or 16% per annum. At the Boltsburn mine, the yield of dressed lead ore was 4,340 tons, and of fluor-spar 300 tons. At the Stanhopeburn mine the yield was 216 tons of dressed lead ore and 11,550 tons of fluor-spar. The Sedling mine yielded 25 tons of dressed lead ore and 4,079 tons of fluor-spar.

Van Ryn Gold Mines Estate. — This company was formed in 1892 to acquire property on the outcrop in the Far East Rand, being in fact the pioneer in the development of this section of the Rand. The assay-value of the ore has always been lower than that in the central part of the Rand, and also less than that in many parts of the deeper levels in the Far East Rand. It was not until 1904 that dividends were paid. Sir George Albu is managing director, and E. G. St. John is mine manager. The report for the year ended June 30 shows that 492,617 tons of ore was raised, and after the rejection of 7% as waste, 456,450 tons was sent to the mill. The yield by amalgamation was 90,780 oz., and by cyanide 41,520 oz., being a total of 132,290 oz., or 5·8 dwt. per ton milled. The gold was worth £552,304, or 24s. 2d. per ton, and the working cost was £348,250, or 15s. 3d. per ton. Out of the profit, £175,000 was distributed as dividend, being at the rate of 35%. Development during the year has been somewhat impeded by scarcity of labour. The reserve on June 30 was estimated at 1,730,772 tons averaging 6·57 dwt., as compared with 1,950,191 tons averaging 6·7 dwt. the year before. In addition to the less development, the necessity to eliminate some of the lower-grade ore from the reserve accounts for this fall in the tonnage of the reserve.

East Rand Gold, Coal, & Estate.—This company was formed in 1895 to acquire the freehold farm Vischkuil, in the Far East Rand. A colliery has been opened, and from 1910 to 1915 was worked profitably. Bores were sunk in the early days to find gold ; they proved the existence of a banket bed, which the directors claimed to be the Nigel Reef, though other authorities believe it to be the Government Reef. The report for the year ended June 30 last shows that 105,678 tons of coal was raised, of which 85,541 tons was sold, giving a profit of £2,205. No dividend was paid. As regards the prospects of developing the gold deposit, nothing can be done at present. The directors refer with regret to the want of success in the boring operations conducted on Rietfontein, adjoining Vischkuil on the west, as these results reflect indirectly on the possibilities for Vischkuil. This Rietfontein must not be mistaken for the farm of similar name adjoining Springs and Brakpan.

Glynn's Lydenburg.—This company was formed in 1895 to acquire a gold mine on the Sabie river, near Pilgrim's Rest, in the Lydenburg district of the Transvaal. The control is with the Central Mining group, and G. C. Damant is manager. Milling started in 1897, and dividends, averaging 20%, have been paid continuously. The report for the year ended July 31 last shows that 49,832 tons of ore, averaging 10·2 dwt., was treated, yielding 7,695 oz of gold by amalgamation and 15,930 oz. by cyanide, making a total of 23,625 oz., worth £99,037, or 39s. 9d. per ton milled. The working cost was £61,934, or 24s. 10d. per ton, leaving a working profit of £37,103, or 14s. 11d. per ton. The dividends absorbed £34,000, being at the rate of 20%. The development during the year at the various properties has given good results, especially at Compound Hill. The reserves at July 31 were estimated at 109,126 tons averaging 8·9 dwt., of which 26,816 tons averaging 10·1 dwt. was in the Mill Hill section, 62,399 tons averaging 7·7 dwt. in the Werf Mynpacht, and 19,911 tons averaging 11·2 dwt. in the Compound Hill. The total was 30,844 tons higher than the year before, and the average content 0·2 dwt. greater. Mr. Damant reports that the stamp-mill requires extensive repair. In order to effect this, without interfering with the output, five new stamps are being erected, and each battery of five of the twenty stamps now in operation will be renovated at a time. When all the 25 stamps are available, it is intended to use a finer screen in order to secure an increased extraction.

Rooiberg Minerals Development.—This company was formed, under Transvaal laws, in 1908 for the purpose of reopening ancient tin workings in the Rooiberg mountains, about 75 miles north-west of Pretoria. The company was floated by the Oceana Consolidated, but the control passed shortly afterward to the Anglo-French Exploration Company. Edward J. Way is consulting engineer, and E. R. Schoch is manager. The report for the year ended June 30 shows that 38,557 short tons of ore was milled and 950 long tons of tin concentrate recovered. The assay-value of the ore was 2·85% of metallic tin, and of the tailing 0·47%. The average metallic content of the concentrate was 67·9%. The percentage of recovery in the dressing plant was 79·8%. The revenue from the sale of concentrate was £119,725, or £3. 2s. 1d. per ton. The cost, including realization charges and development, was £96,050, or £2. 9s. 10d. per ton, leaving a working profit of £23,675, or 12s. 3d. per ton. A dividend of 5% has been paid, absorbing £9,000. Developments during the year have not disclosed any new supplies of ore of importance. The reserve is estimated at 11,248 tons averaging 2·33% of metallic tin, showing a substantial fall during the year. Some anxiety is expressed by the engineers as to the future.

Matabele Queen's.—This company was formed in 1910 as a subsidiary of Willoughby's Consolidated to acquire a gold mine and mill situated about 28 miles north-east of Bulawayo. No dividend has been paid. The report for the year 1916, only just published, shows that 21,623 tons of ore was raised and treated, for a yield of gold worth £35,763. The financial result of the year's work was a loss of £1,895. The ore reserve at December 31 was estimated at 14,120 tons averaging 9 dwt Since that date, the inclined internal shaft has been sunk deeper, and 10th and 11th levels have been opened. A. H. Ackermann, the company's consulting engineer, reports that the results have been gratifying, and that 17,000 tons averaging 14 dwt. has been added to the reserve.

Gaika Gold.—This company was formed in 1902 to acquire a gold-mining property near the Globe & Phœnix, Rhodesia. Willoughby's Consolidated and the Rhodesia Exploration & Development were concerned in the flotation ; since 1912 the control has been with the Gold Fields Rhodesian Development Co. Milling commenced in 1905 and dividends have been paid since 1911. Two years ago the ore-bodies began to disappear in depth. The report for the year ended June 30 shows that exploration in depth continues to give poor results, though development elsewhere has proved additional ore. The reserve now stands at 85,831 tons, averaging 12·9 dwt., a fall of 3,760 tons and 1 dwt. as compared with the figures a year ago. During the year, 38,320 tons of ore averaging 11·17 dwt. was treated, yielding by amalgamation and cyanide 19,649 oz. of gold, worth £84,006, or 43s. 10d. per ton. The working cost was £56,493, or 29s. 6d. per ton, leaving a working profit of £27,513, or 14s. 4d. per ton. After allowing for depreciation and London expenses, a net balance of £21,097 was left, to which was added £14,609 brought forward from the previous year. Out of this, £34,186 has been distributed as dividend, being at the rate of 12½%. Cyril E. Parsons, the consulting engineer, recommends the inclusion in the reserve of some ore of lower grade; thus the yield per ton will be decreased and the life of the mine prolonged.

Eileen Alannah.—This company was formed in 1911 as a subsidiary of Willoughby's Consolidated for the purpose of working a gold mine in the Gatooma district of Rhodesia that had been previously let on tribute. As the oxidized ore was nearing exhaustion, it was necessary to provide a new plant capable of dealing with arsenical and antimonial ore found below. The new plant started in June, 1915. The report for the year 1916, only just published, shows that 47,380 tons of ore, averaging 9 dwt., was treated, for a yield of gold realizing £94,914. Extraction has been substantially improved, and the loss in the tailing is now 1·9 dwt. as against 3·1 dwt. the year before. The accounts show a net profit of £21,059, out of which £19,898 was distributed as dividend, being at the rate of 5%. The ore reserve on December 31 last was estimated at 185,543 tons averaging 10·5 dwt., of which 156,751 tons averaging 10·66 dwt. was in the Eileen Alannah, and the remainder in the Egglantine and Blue Duck. Prospecting by bore-hole both in depth and laterally is now being conducted.

Selukwe Columbia Gold Mine.—This company was formed in 1899 as the Yankee Doodle Development Co., by the Rhodesian Exploration & Development Co., for the purpose of acquiring the Yankee Doodle mine, in the Selukwe district of Rhodesia. Milling commenced in 1909. Control passed in 1911 to the Gold Fields Rhodesian Development Co. The mine was let to a tributer in 1913, and afterward the Wonderland group in the Gwelo district was acquired. The report for the year ended June 30 last shows that 16,326 tons of ore was raised and treated, of which 1,988 tons came from the Wonderland mine, 6,661 tons from the Danga, and 7,677 from the Chimborazo. The yield of gold was worth £32,692, and the net profit was £4,979, which, added to the balance brought forward, made an available balance of £10,307. Out of this, £9,350 has been distributed as dividend, being at the rate of 6⅝%. The ore reserve is estimated at 27,760 tons averaging 10 dwt., as compared with 22,214 tons averaging 10·5 dwt. a year ago.

Taquah Mining & Exploration.—This company was formed in 1888 as the Taquah & Abosso Gold Mining Co. to acquire gold-mining properties in Gold Coast Colony, West Africa. From 1892 to 1898, milling was conducted on a small scale. In 1901 the company was split, and the Abosso mine worked as a subsidiary. The control passed to the Oceana Consolidated in 1910, and additional capital was then provided for development. The first dividend was paid in 1909, and no more until 1914, since when the distribution has been well maintained at 15 to 20%. The report for the year ended June 30 shows that 63,883 tons of ore averaging 56s. 5d. per ton was raised and milled, for a yield of gold worth £175,643 or 54s. 11d. per ton The percentage of recovery was 97·4%, and the assay-value of the final residue was 1s. 5d. per ton. The working cost was £117,897, or 36s. 10d. per ton, and after allowance for depreciation, etc., the net profit was £48,364. Adding the sum of £36,820, the total balance of profit was £85,184. Out of this, £58,121 has been distributed as dividend, being at the rate of 15%. The ore reserve is estimated at 213,347 tons averaging 56s. 10d. per ton over a stoping width of 60 inches. These figures compare with 209,299 tons and 56s. 9d. a year ago. Development has been centred on the new ore-shoot discovered two years ago. The first work on this shoot had been done from the 10th and 11th levels. During the past year, the shoot has been proved on the 9th and 12th levels, and development is in hand at both higher and lower levels. G. W. Campion is the manager.

Abosso Gold.—This company is a subsidiary of the Taquah and was formed under circumstances detailed in the preceding paragraph. Dividends have been paid since 1906, except in 1912 and 1917. The report for the year ended Juue 30 last shows that 112,460 tons of ore was treated, for a yield of gold worth £167,270, equal to 29s. 9d. per ton. In addition, gold worth £3,481 was extracted from 9,384 tons of accumulated slime. The working cost was £146,850 or 26s. 1d. per ton milled. After allowing £10,120 for depreciation, a net profit remained of £10,416. Owing to the necessity of keeping a larger supply of stores, this profit is not available for a dividend. The developments during the year have continued favourable, and the reserve on June 30 was estimated at 265,400 tons averaging 32s. 6d. per ton, as compared with 237,280 tons of the same average a year ago. There are also several large blocks of ore, exposed on two sides only, that should materially add to the reserve. C. E. Jobling is the manager.

Broken Hill South Silver.—The report of this company for the half-year ended June 30 last, shows that scarcity and inefficiency of labour caused the weekly output of ore to be below normal. During the period 122,240 tons was raised and sent to the lead concentrator, as compared with 157,460 tons during the previous half-year. The average assay-value was 13·7% lead, 13·3% zinc, and 6·6 oz. silver per ton. The yield of lead concentrate was 18,180 tons, averaging 66·3% lead, 7·2% zinc, and 23·2 oz. silver; of zinc tailing 70,671 tons, averaging 16·7% zinc, 3·6% lead, and 3·4 oz. silver; and of slime 18,387 tons, averaging 10·4% lead, 12·6% zinc, and 7·8 oz. silver. The current zinc tailing was delivered to the Amalgamated Zinc (De Bavay's) Ltd., and 24,867 tons of old tailing from the dump, averaging 18% zinc, 7·2% lead, and 4·1 oz. silver, was delivered to the Zinc Corporation. The plant for treating the slime by selective flotation has been extended, and the whole of the current output was treated. The yield of lead concentrate was 2,482 tons averaging 61·9% lead, 7·8% zinc, and 49·4 oz silver, leaving 15,905 tons of zinc tailing averaging 13·4% zinc, 2·4% lead, and 1·2 oz. silver. This tailing will be treated in the zinc section of the slime-flotation plant when the opportunity of selling zinc concentrate improves. The accounts show an income of £474,215, and a net profit of £232,500, out of which £120,000 has been distributed as dividend, being at the rate of 12s. per £1 share. During the half-year, prospecting on the 1,370 ft. level by diamond-drilling has given excellent results.

British Broken Hill.—This company was formed in 1887 to purchase Blocks 15 and 16 from the Broken Hill Proprietary. The property has not been one of the most successful of the Broken Hill group of silver-lead-zinc mines. The original capital has been scaled down, and additional capital has been subscribed on two occasions. Mining operations have been twice suspended owing to the low price of metals. Work also ceased on the sulphide ore at the outbreak of war, to be resumed in January of this year. In 1912 a new ore-body was discovered. The report for the half-year ended June 30 last shows that 4,632 tons of carbonate ore, averaging 26·8% lead and 6·2 oz. silver, was extracted from the upper levels of Block 15, and that 74,607 tons of sulphide ore was raised, averaging 12·8% lead, 11·4% zinc, and 7·2 oz. silver. At the lead concentrator, 75,349 tons of ore was treated, for a yield of 11,056 tons of lead concentrate averaging 64·7% lead, 62·% zinc, and 26·3 oz. silver. The flotation plant treated 55,158 tons of zinc tailing, averaging 12·2% zinc, 3·1% lead, and 3·4 oz. silver, for a yield of 12,020 tons of zinc concentrate averaging 44·1% zinc, 9·2% lead, and 11·1 oz. silver. At the lead mill, 9,145 tons of slime averaging 8·5% lead, 12·8% zinc, and 7·1 oz. silver was produced; this has been stacked for future treatment. The accounts for the half-year show credits of £188,015 for mine products sold and on hand, and a profit of £40,553. The directors have declared dividends absorbing £37,500, being 2s. on the 315,000 shares of £1 each, and the same on the 60,000 privileged shares of 8s. each.

Menzies Consolidated Gold Mines.—This company was formed in 1895 by C. Williamson Milne to acquire gold mining properties at Menzies, in the North Coolgardie goldfield, West Australia. The late Bedford McNeill was for many years consulting engineer. R. Goninon is manager. The company was reconstructed in 1898. Dividends of 2½% each have been paid for the last four years, on a capital of £224,015. The report for the year ended July 31 last shows that 25,650 tons of ore was milled, yielding £25,595 by amalgamation, £15,579 by cyanide, and £12,425 in concentrate, being a total of £53,600. The working cost was £44,120, and, after allowing for London expenditure, income tax, and depreciation, a net profit of £3,245 remained. This, being added to the balance brought forward, made a disposable balance of £8,529, out of which £5,600 has been distributed as dividend, being at the rate of 2½%. During the year, the 17th level has been opened, and though the ore is not of so good quality as that on the 16th, the reserve has been maintained. The reserve is estimated at 109,344 tons averaging 36s. 7d. per ton, as compared with 103,625 tons averaging 38s. 2d. the previous year. An 18th level is now being opened.

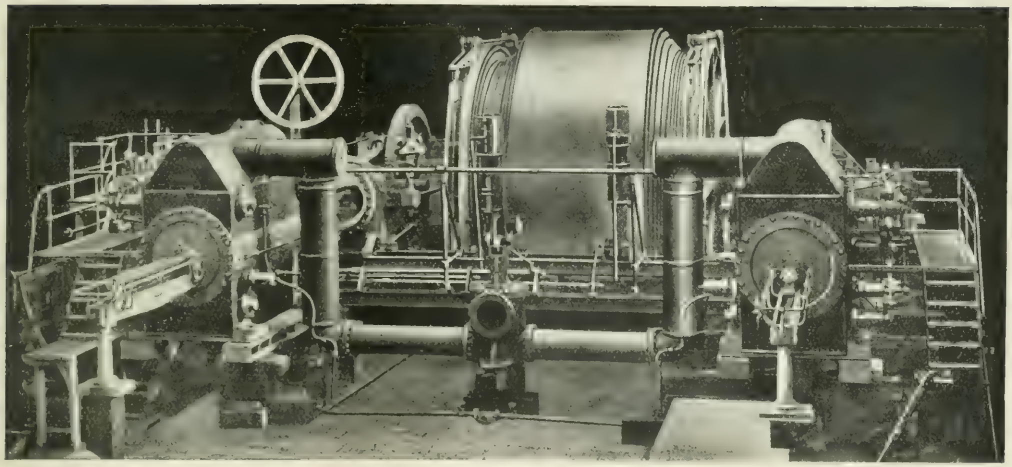
Kalgurli Gold.—This company was formed in 1897 to acquire property at Kalgoorlie, West Australia. Large dividends were paid from 1901 onward, but two years ago the limits of the rich ore were reached. It is now about four years ago since Dr. Malcolm Maclaren defined the limits of the ore-body, and no high-grade ore has been found since. The report for the year ended July 31 last shows that 103,210 tons of ore was raised and treated, for a yield of gold worth £179,837, as compared with 119,180 tons and £194,795 the year before. The net profit was £41,224, out of which £30,000 has been distributed as dividend, being at the rate of 25%. R. S. Black, the manager, reports that the measurable quantity of ore likely to be profitable under present conditions is limited to a few months supply, and there remains little ground unprospected.

Huelva Copper & Sulphur Mines.—This company was formed in 1903 to operate the Monte Romero and other pyrite mines in the South of Spain, previously worked by the Huelva Central Copper Mining Co. At first the copper was extracted by the cementation process, but subsequently, under the guidance of Henry F. Collins, a smelting plant was erected and the copper is now mostly produced as blister. Profits have been made under this system of treatment, but have had to be devoted to writing-off for previous failures. The report for the year ended June 30 last shows that 63,385 metric tons of ore was raised, and that, together with purchased ores, 95,380 tons was smelted, for a yield of 1,753 tons of blister copper. The sales brought an income of £246,887, and the net profit was £8,583, which was carried forward. The plan to increase the amount of low-grade ore sent to the washing floors has been deferred for the time, owing partly to the difficulty of securing cheap supplies of iron for precipitation purposes, and partly because it is considered best to extract as much copper as possible by smelting, during the period of high prices, instead of extracting it by the slow cementation process. Large sums have been spent out of income on exploration and development, and the reserve, which had fallen uncomfortably low, has been raised by 40,000 tons, to 103,800 tons. The completion of the hydro-electric power station has been delayed by the difficulty of obtaining delivery of machinery.

Central Chili Copper.—This company was formed in 1894 to work the Panulcillo copper mine, near Coquimbo, Chile, that had been previously operated for many years by the Panulcillo company. Neither the present nor the old company has given much return on the capital invested. The present company paid dividends of 2½%, 2½%, and 5%, for the years 1900, 1901, and 1907. The report for the year 1916, just issued, shows that 33,580 metric tons of ore was raised from the company's mines, averaging 2·38% copper, as compared with 30,853 tons averaging 2·52% in 1915. The company purchased from outside mines 32,802 tons of copper ore averaging 8·4%. The smelter treated 32,361 tons of the company's ore, and 28,268 tons of purchased ore. The matte produced returned 2,721 tons of fine copper, 65,323 oz. silver, and 1,560 oz. gold. The accounts show a net profit of £59,375, but no dividend is recommended.

St. John del Rey.—The report of this company, which has operated the Morro Velho gold mine in Brazil since 1828, for the half-year ended August 31 last shows that 99,500 tons of ore was raised, and after the rejection of waste, 94,300 tons was sent to the metallurgical plant. The yield of gold below the stamps was worth £175,150, and by cyanide £65,056, making a total of £240,206. The silver content brought the total yield to £242,620, the yield per ton milled being 51s. 5d. The working cost was £164,414, and £20,000 was placed to capital account for expenditure on development and plant. Out of the profits, the usual preference dividend was paid, absorbing £5,000, and a dividend of 9d. per share on the £546,265 ordinary shares was paid. The gold is now being shipped to New York in order to escape the submarine menace. As regards development, "H" shaft and a winze have been sunk below the 20th horizon, which is 5,826 ft. vertically below outcrop. The winze attained its full depth, 303 ft., on August 24, and the H shaft was down 246 ft. by the end of August. The development of a 21st horizon at 6,126 ft. is now in hand.

Naraguta (Nigeria) Tin Mines.—This company was formed in 1910 to acquire alluvial tin ground at Naraguta, Northern Nigeria. Other properties have been acquired since, at Karama in the Ninkada district, at Sho near Zungeru, and at Korot. F. N. Best is chairman, C. G. Lush is consulting engineer, and F. O'D. Bourke is manager. The report for the year ended March 31 last shows that the output of tin concentrate was 520 tons as compared with 580 tons the year before. The fall is partly due to the fact that, at the Naraguta property particularly, the ground has been treated as it came without choosing the best portions, The output at Naraguta was 373¼ tons, at Karama 58⅝ tons, at Sho 73 tons, and at Korot, where work was only recently started, 15½ tons. The accounts show receipts of £63,658, and a net profit of £14,724. Adding this to the balance brought forward from the previous year made a disposable balance of £32,854, out of which £26,250 has been distributed as dividend, being at the rate of 15%.



COMPANY MEETINGS and REPORTS SECTION

FANTI CONSOLIDATED MINES, LIMITED.

Directors : Lord Teynham (*Chairman*), Edmund Davis (*Managing Director*), E. W. Janson, D. J. Neame, H. Strakosch, Lt.-Col. C. H. Villiers. *Secretary :* J. Coltman. *Office :* 19, St. Swithin's Lane, London, E.C. *Formed* 1900. *Capital issued :* £610,560 in shares of 10s. each.
Business : The financing of mines in West Africa, Nigeria, and elsewhere.

The ordinary general meeting of Fanti Consolidated Mines, Ltd., was held on December 4 at the Cannon Street Hotel, London, E.C., Mr. Edmund Davis (Managing Director) presiding, in the absence of the Chairman (Lord Teynham).

The Secretary (Mr. J. Coltman) having read the notice convening the meeting.

The Chairman said : Gentlemen, – We now present our accounts at December 31, 1916. I will first draw your attention to the main items appearing in the balance sheet and profit and loss account. The issued capital is £610,560 in 1,221,120 shares of 10s each. Creditors and credit balances, £1,808. 11s. have all been dealt with since the date of the accounts, the only other item on this side of the balance sheet being balance of profit and loss account, £5,232. 3s. 6d., to which reference will be made later. On the other side of the balance sheet we have cash, Treasury bills, loans and interest accrued, debtors and debit balances, £110,364, comparing with £106,929 at December 31, 1915. Four-and-a-half per cent. War Loan is the same as in the accounts for the previous 12 months, but, as you will see from the list of holdings in the report, it has been converted into Five per cent. Loan, and added to. Shares and interests in other companies in our present balance sheet stand at £434,411, comparing with £446,784 at December 31, 1915, or a reduction of £12,373, but at December 31, 1915, the holdings, which stood in our balance sheet at £446,784, were worth, at market prices or valuation where there was no quotation, but in that case not over average cost, £376,300, showing a depreciation of £70,484. In the accounts before you the holdings, valued on the same basis, were worth at December 31 last £359,227, the depreciation being £75,184. Leasehold mining and other properties in West Africa stand at £21,691, as they include not only £13,015, the amount at which they stood in the balance sheet at December 31, 1915, but also the sum of £8,676, being the amounts written off in 1914 and 1915, now reinstated, in view of the discovery of manganese. Building plots and bungalows, at £2,305, and stores and equipment, £202, are the remaining items on this side of the accounts. In the profit and loss account the items of expenditure are set out in detail, the London figure amounting to £3,194, comparing with £5,887 for the year ended December 31, 1915 ; and the West African, £204, comparing with £250 for the previous 12 months. At December 31, 1916, we found it necessary to write £31,765 off shares and interests, this being caused by the serious fall in the market price of our holding of 300,000 shares in the Prestea Block A, Ltd. The only other item which calls for attention is interest and dividends, which for the year under review amounted to £24,723, a reduction of £5,293 as compared with the previous 12 months, the principal cause of the reduction being that more interest-yielding securities were held in 1916, and consequently less money was employed on loans at higher rates.

Having dealt with the accounts, I desire to refer to the position of the company at to-day's date. In the report we have referred to the substantial depreciation in the value of some of the shareholdings, which renders the payment of dividends impossible. For all practical purposes you may take that depreciation as arising from two holdings, namely, 255,431 shares of Abbontiakoon Mines, Ltd., and 300,000 shares of Prestea Block A, Ltd. The Abbontiakoons stood in our books at December 31 last at 7s. 10·2d. per share, but in our valuation referred to in the balance sheet are included at the market price, namely, 5s. The Prestea Block A's stood in our accounts at December 31 last at 10s. but in our valuation at 6s. 9d. At the present moment there is a further depreciation on these two holdings, and it is better that this depreciation should be dealt with, as, while the company's interests show an increased revenue-earning capacity, yet it will be impossible to make distributions so long as there is a loss shown on the cost of the holdings referred to. We propose to you that application should be made to the High Court for the reduction of the capital of the company by the writing off of 2s. per share, and, so that the position should be clear, we have set it out at October 31, 1917, in the report, and that is for all practical purposes the position to-day. At October 31, 1917, the liabilities consisted of capital, £610,560, creditors £6,647, and a balance standing to credit of profit and loss account £53,873. On the credit side we have set out sundry shares and interests, £577,987, which is our valuation, though these holdings stand in our books at £507,163 ; properties at cost, £24,474 ; sundry debts, including loans which are quite good, £113,658 ; stores, £111 ; and cash at bankers and in hand, £25,673, showing a deficiency of £129,176 when compared with the other side of the statement. Practically the whole of this deficiency has arisen through depreciation in our holdings in the Prestea Block A, Ltd., and the Abbontiakoon Mines, Ltd.

It is apparently possible to misunderstand the position of the company, as reference has been made in the press to its unsatisfactory financial position, and for that reason I wish to deal at greater length with the subject, though the position might surely have been understood had some attention been paid to the principal holdings of the company referred to in the report. To save misunderstanding it is only necessary to state that at October 31, 1917, included in our valuation of sundry shares and interests, £377,987, are the holdings in War Loan, India stocks, New South Wales Debentures, Union of South Africa Government, Victorian Government and Nigerian Government bonds, British South Africa Company, Chinese Engineering and Mining Company, Ltd., Rhodesian Lead and Zinc Syndicate, Ltd., and Wankie Colliery Company, Ltd., Debentures, which could be realized at very short notice, for about £159,500. Adding this sum to sundry debts, £113,658, which we estimate are all good, and cash at bankers and in hand, £25,673, we have a total of £298,830. Surely a company with an issued capital of £610,560 is in a sound financial position if it has £298,830 to deal with at short notice. We now come to the question of revenue, which at October 31, 1917, showed a balance for the first ten months of the current financial year of £53,873 to the credit of profit and loss account; deducting £5,232 brought in at December 31, 1916, leaves a balance for the first ten months of the current year of £48,641. Were our capital reduced and as we anticipate no further provision will be required for depreciation, there would be, with such revenue, a large amount available for distribution in each year after the reduction of capital, and it is with this object that we are recommending the scheme. In view of the support we have received in the form of proxies from shareholders of the company in favour of the scheme, holding 508,004 shares, we are satisfied that it was the proper thing to propose at the moment, and we trust that the resolution necessary to give it effect will have your unanimous support. One shareholder holding 150 shares has sent in his proxy to be used to vote against the proposal.

There is one other matter to which your special attention should be drawn, and that is the working of the very extensive manganese deposits on the Dagwin Extension Concession owned by the Wassaw Exploring Syndicate, Ltd., which is controlled by us, and the interest we have in that portion of the manganese deposit which runs into the adjoining property, the Dagwin Concession, in which our interest is two-fifths. The first intimation relating to the discovery was conveyed to the Wassaw Exploring Syndicate by His Majesty's Government on May 10, 1916, requesting the syndicate to make arrangements with the Darwen and Mostyn Iron Company, Ltd., for the working of the Dagwin Extension property. We took steps for the immediate development of the proposition, and at our last meeting of shareholders we referred to our negotiations with the Colonial Office on the subject of sidings, and stated that they should be immediately constructed by the Government, which has been done, we contributing towards the cost. Shipments commenced in September, 1916, great credit being due to our representative and staff on the other side for the rapid way in which the proposition has been developed and worked and shipments effected, as up to November 28, 1917, 24,786 tons had been shipped and sold from the Dagwin Extension and 5,961 tons from the Dagwin Concession.

We have done everything possible to develop the manganese proposition referred to on a large scale, and we are now in a position, with our present limited supply of labour, to mine and produce 5,000 tons per month from the Dagwin Extension and Dagwin properties. The Gold Coast Railway is ready to carry—provided the traffic is regular—250 tons per day, and the Lighterage Company at Seccondee to ship 200 to 300 tons. To secure a regular supply of ore for the railway and boats it will be necessary to arrange for the storing of large tonnages at Seccondee, and we hope that the Government will provide the requisite accommodation. We may, perhaps, not be allowed to provide the facilities we require at the port, though we are willing to incur the necessary capital expenditure for any reasonable accommodation afforded us. On the Dagwin Extension property large steel bins will now be built, so that no delay can possibly arise at the mine and if suitable containers to save unnecessary handling are provided either by the railway or by ourselves there should be considerable acceleration of traffic on the line. If such containers are provided we are of opinion that there should be a reduction in the railage rate on the ore and in lighterage at the port, as not only will tonnage be handled at a more rapid rate, but there will be a great saving in the wear and tear of the rolling stock and of the lighterage craft.

The directors are of opinion that a very large proportion, if not the whole, of our own country's requirements could be produced within the Empire, but for the Gold Coast Colony to complete in normal times it will be necessary to reduce all costs and, in particular, railage, lighterage, and freight. As far as railage is concerned, the ore is carried about 33½ miles at a cost to us of 7s. per ton. The lighterage is 6s. 6d. and present freight 60s. with 10% war tax on both the latter. We are looking ahead, as it is not only necessary when developing and equipping such a proposition as ours to look at the possible immediate profits, but we must also consider what the position may be after the war. As far as the railage is concerned, the Gold Coast Colony has the satisfaction of showing a return of about 9% on this investment, and therefore there should be room, if necessary, at a later date to reduce the rate we are at present paying. As regards lighterage, if facilities are provided for quicker dispatch and the avoidance of excessive depreciation of the craft, there should be a considerable reduction in the rate we are paying, but as regards freight it is, of course, impossible now to express any opinion as to what could be done on the conclusion of hostilities. It is, however, interesting to note that from June, 1913, to June, 1914, the highest freight paid on manganese ore from Rio de Janeiro to European ports was 14s. and the lowest 10s.; during the same period from Indian to European ports the highest and lowest rates were 23s. and 14s. 6d. respectively, and from Russia to European ports 17s. and 8s. respectively.

As regards the development of the properties in which we are interested, first there is the Dagwin, in which we have a two-fifths interest, the latest reports being for the week ended October 20, 1917, when there was in stock on the mine 6,350 tons, of which from 4,000 to 5,000 tons was shipping ore. On the Dagwin Extension at the same date there was in stock on the mine about 15,000 tons of ore, of which about 10,000 tons was shipping ore. On the Dagwin Extension we have now proved the existence of the deposits right through the property and into the Insuta Concession, but until a large amount of development work is done, it is impossible to give any accurate statement as to the extent of the deposits.

Mr. Edmund W. Janson seconded the motion, and it was carried unanimously.

The Chairman next moved: "That the capital of the company be reduced from £750,000, divided into 1,500,000 shares of 10s. each, to £600,000, divided into 1,500,000 shares of 8s. each, and that such reduction be effected by writing off paid-up capital to the extent of 2s. per share on each of the 1,221,120 shares Nos. 1 to 1,221,120, inclusive, which have been issued and which are now outstanding, and by reducing the nominal amount of 1,500,000 shares of the company's capital from 10s. to 8s. per share."

Lieut.-Colonel C. H. Villiers seconded the resolution, which was unanimously adopted.

TAQUAH MINING & EXPLORATION CO. LTD.

Directors: T. F. Dalglish (*Chairman*), M Attenborough, J. F. D. Bowden, F. H. Hamilton, Sir James S. Hay, Sir Westby B. Perceval. *Secretary:* T. J. Foster. *Office:* 461 Salisbury House, London, E.C.2. *Mine Manager:* G. W. Campion. *Formed* 1900. *Capital issued*: £349,979 in £1 shares.
Business: Operates the Taquah gold mine in West Africa; holds a large interest in the Abosso Gold Mining Co. which works a mine in the same district.

The seventeenth ordinary general meeting was held on November 29 at River Plate House, Finsbury Circus, London, E.C., Mr. T. F. Dalglish (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, said that the value of the gold produced during the year was £175,643, as against £202,059 in the previous year. This decrease of £26,416 arose from the decision of the board to reduce the average mill-head value of the ore to be treated to 55s., as intimated by the circular of June 30, 1916. The tonnage crushed was 63,883 tons, and 97·4% of the gold contents was recovered. The average assay of the final residues was only 1s. 5d. per ton. The total costs, including development redemption and London expenses, amounted to £117,897, an average of 36s. 10·92d. per ton crushed, against 34s. 3·8d. in the previous year. The increase of 2s. 7·12d. per ton was accounted for by the advance in cost of stores and materials, freights, &c. While the war lasted these costs were more likely to increase than diminish. The working profit was £59,599. After taking into account the dividend received on their Abosso shares and making adequate provision for depreciation and other sundry items, a balance of £48,364 was carried to appropriation account. Adding the balance of the latter account at June 30, 1916, they had a total credit of £85,184, from which they had paid three dividends, each of 1s. per share, absorbing £58,121. It was recommended that the balance of £27,062 should be carried forward to the current year. They were paying an interim dividend of 1s. per share on December 15. They had increased their stock of stores and materials by some £5,000 as a provision against contingencies. This increase represented not only the additional cost of supplies, but an actual increase in quantity. The ore reserves at the date of the balance sheet stood at 213,347 tons, of an average mill-head value of 56s. 10d. per ton. This figure showed a small increase, and the value was about the same as in the previous year. Their investment in War Loan had been increased to £19,585.

Development work during the year had been mostly devoted to the West Reef. The lens referred to in the report last year had, at the date of the latest advice, been exposed in four levels; in fact, from 120 ft. above No. 9 level to 153 ft. below No. 12, a distance of 840 ft. on the dip of the reef. In levels No. 9 and No. 10 they found the reef duplicated, and in some cases triplicated. At one point in No. 9 level they had two quite distinct reefs, giving respectively assay-values of 49s. 3d. over 55 in. and 40s. over 45 in. At a second point they had three reefs of the following values: 57s. 6d., 31s., and 74s., each over a width of 60 in. At a third point they had again two reefs, with values of 65s. over 54 in. and 50s. over 45 in. respectively. These points extended over a distance of 200 ft. Again, in No. 10 level, they had at one point two distinct reefs with values of 44s. and 65s. respectively, both over 50 in. At another point, 126 ft. away, there were three reefs giving values of 52s. 9d. over 54 in., 55s. over 53 in., and 56s. 9d. over 52 in. respectively. In levels Nos. 11 and 12 there was so far no duplication. The reef exposed in these levels showed an average assay-value of 44s. 3d. over 47 in. and of 46s. over 50 in. All these assays indicated a considerable addition to the reserves of ore of good average value when the development was complete. In level No. 5, which was being continued in the same section of the mine, high values over a narrow width of reef had been disclosed, but the drift was not far enough in yet to prove its payability. Regarding the old lens from which they had been drawing their main supply of ore, they were now sinking an internal shaft below No. 13 level to follow it up. This shaft was being sunk under the foot-wall of the reef, and had reached a depth of 220 ft. At 85 ft. down they proved the reef, and found the value of 50s. 6d. over 59 in. and at another point 70s. over 60 in., and at 220 ft. the value was 55s. over 56. in.

At a meeting of a West African mining company recently it was suggested that they had somewhat wantonly raised native wages, although natives were content with the old rate, and that companies ought to work together. He did not propose to say much on this score, except that attempts had been made by their management to work together on labour problems, and that such attempts had been most definitely rejected. If the man on the spot refused to act it was useless to talk platitudes here. Labour throughout the world was calling for higher wages in consequence of the increased cost of living. West Africa was no exception to the rule. Their boys fed themselves, and, as imported foodstuffs had increased anything up to 150% in price, this was bound to be reflected in wages paid. Boys would not come to work at the mines unless they could make more than their keep, especially when other and more congenial work was to be had. The enormous increase in the cocoa industry now employed many thousands of boys formerly available for mine work. The position would have become a very serious one indeed for the mines had not this drain on labour been checked by two things: first, the action taken by His Excellency the Governor (Sir Hugh Clifford) in constructing roads through the Colony as an alternative to his policy of railway extension, which was stopped by the war; and, second, the enterprise of Messrs. Miller and Swanzy in the development of their motor transport for the conveyance of cocoa by road. Hundreds of boys who would otherwise have been employed carrying or rolling casks of cocoa over bush tracks were thus freed for other work. Labour had been, was, and would be a difficult problem, but their experience was that fair wages and fair treatment paid, and that was the policy they proposed to follow.

Shareholders would probably like to know something as to the position regarding the excess profit tax. An appeal had been lodged with the Referees, but had not yet been adjudicated upon. As this tax would bear particularly hard on the company, in view of the many years of initial work before results were obtained, they hoped that the datum line of profit would be fixed at such a figure as would free them from liability.

Mr. Mark Attenborough seconded the motion, which was carried unanimously.

ABOSSO GOLD MINING CO. LTD.

Directors: T. F. Dalglish (*Chairman*), M. Attenborough, D. H. Bayldon, F. H. Hamilton, Sir James S. Hay, Sir Westby B. Perceval. *Secretary:* T. J. Foster. *Office:* 461 Salisbury House, London, E.C.2. *Mine Manager:* C. E. Jobling. *Formed* 1901. *Capital:* £400,000.
Business: Operates the Abosso gold mine, West Africa.

The seventeenth ordinary general meeting was held on November 29 at River Plate House, Finsbury Circus, London, E.C., Mr. T. F. Dalglish (Chairman of the company) presiding

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, said that the value of gold recovered was £170,751, a fall of about £11,500 from the previous year. The tonnage treated was practically the same as in 1915–16, but the recovery was only 29s. 9d. per ton. Owing to the inefficiency of the power plant they were not always able to stope ore from the lower levels, where the richer ore lay, and consequently it had been impossible to send a fair average of the reserves to the mill. For the same reason the secondary treatment plant was stopped from time to time. The working profit for the year amounted to £24,228. After making the usual provision for depreciation, shaft expenditure, and taxes, a balance remained of £10,416. Owing to the difficulty of obtaining supplies and of their transport it had been deemed a wise policy to make sure that the stock on the mine was sufficiently in advance of requirements. Expenditure connected therewith had absorbed more than the whole of the profit earned during the year. The directors, therefore, regretted that they were unable to recommend any distribution by way of dividend.

The year under review had been one of continuous struggle with the power plant. The gas engines had been a source of constant worry, and work had been much interrupted. The board decided some time ago that the only remedy was to substitute steam power, but then the difficulty presented itself of getting a proper engine. The Ministry of Munitions did not allow new engines to be built for any purposes other than its own, and a strong control was exercised over the shipment of even secondhand ones. After much trouble they were able to secure a suitable secondhand steam engine, with electric generating plant, and, having obtained permission of the authorities, it was shipped to the coast. It had, unfortunately, been lost owing to enemy action. They trusted they should be more fortunate with the smaller unit which they were now sending out. When it was erected they would be less dependent on the gas engines, and they trusted they would then have a straight run and recover some of the leeway. They would send out a larger unit when they found a suitable one, so as to place the question of power on a thoroughly safe basis.

At the mine, the prospects seemed promising. The ore reserves at June 30 last were estimated at 265,400 tons, of an average mill-head value of 32s. 6d. per ton. This showed an increase of 28,000 tons over the reserves of the previous year. The value per ton was the same. The special interest lay in the West Reef, which was developing satisfactorily in the main shaft section. During last year the drives, winzes, and rises had been extended for 1,820 ft. The reef exposed averaged 53 in. in width, and gave an average value of 37s. 3d. per ton. Since June 30 a further 381 ft. had been exposed, the average value being 38s. 7½d. per ton over an average width of 48 in. As the average value of the ore reserves at June 30 last was 32s. 6d. per ton, these values in the West Reef suggested the possibility of raising the mill-head value of the ore to be treated, provided it could be mined fairly clean. Although they had been concentrating work on the West Reef, they were not by any means finished with the Main Reef. A large block of ore had still to be developed in and below No. 13 level. The native labour was fairly well maintained, although they naturally felt the competition of the cocoa industry, which had increased so enormously. New compounds had been added to their native village and everything was being done to make the mine attractive. By arrangement with the Taquah Company, they had been able to obtain the co-operation of their manager, Mr. G. W. Campion, who had done such successful work in the Taquah mine. He was familiar with the Abosso mine, having had actual charge of it some years ago, when good results were being obtained from the operations. He had left for the Coast, and would be joined a few weeks later by Mr. Jobling, their mine manager.

During the year working costs only increased by approximately 6d. per ton. Bearing in mind that freights and the prices of commodities had appreciated enormously during the year, this result must be regarded as eminently satisfactory, so much so, indeed, that it would be unreasonable to think that it could be improved upon, or even maintained, in the near future so long as present conditions obtained. He did not propose to enter upon a detailed discussion of the position which was being created by the operation of the steady increase of all prices upon the production of gold, for which the price was fixed. It was, however, already evident that the pressure upon many of the low-grade mines throughout the world was becoming irresistible. The output of gold from West Africa had shown a small but apparently progressive decrease, and the same tendency was manifest everywhere. There was no reason to think that this tendency would weaken; indeed, there was every reason why it should become stronger and more apparent. It was quite evident that it was impossible to increase indefinitely the cost of production and at the same time maintain a fixed price for the article produced, without decreasing the total yield and causing grave injury to the industry itself. Before very long it seemed to many that the Imperial Government, which was more nearly concerned in the maintenance of the gold output than any other, would have to face this position squarely. That was a simple question of figures. Hitherto the Government had not attempted to afford any measure of relief, and had, indeed, not shown a glimmer of recognition of the distinction between the conditions governing the production of gold and those applying to all other commodities, which could accommodate themselves to increasing costs by advancing the price of the product. The logic of facts, however, was bound to tell, and it was not altogether improbable that, within the near future, steps would be taken to lighten the burden upon the medium and lower grade mines, which to-day produced the bulk of the world's gold.

Mr. F. H. Hamilton seconded the motion, which was carried unanimously.

ASHANTI GOLDFIELDS CORPORATION, LIMITED.

Directors: The Earl of Bessborough *(Chairman)*, Jeremiah Colman, Charles W. Mann, G. Lawson Johnston. *Consulting Engineer:* W. R. Feldtmann. *Mines Manager:* John Swan Watkins. *Secretary:* Horace Morgan. *Office:* 6, Southampton Street, Holborn, London, W.C.1. *Formed* 1897. *Capital issued:* £220,611. 8s. in shares of 4s. each.

Business: Operates a group of gold mines at Obuasi, Gold Coast Colony, West Africa.

REPORT AND ACCOUNTS OF THE DIRECTORS
To be submitted to the Twentieth Ordinary General Meeting of Shareholders.

The Directors herewith submit the statement of accounts for the financial year ended June 30, 1917. The issued share capital remains at 1,103,057 shares of 4s. each, fully paid up, or £220,611. 8s. 0d., out of a total authorized capital of £250,000.

The income from all sources was				£486,702	6	5
The working costs in West Africa, general expenses and other charges in London amounted to				217,139	4	3
Showing a working profit of				269,563	2	2
From which has been deducted:						
Cost of Mines Development	£47,209	18	2			
Government Royalty	23,816	2	4			
Amounts written off Main Shafts and for depreciation of plant, machinery, &c.	21,851	18	11			
				92,877	19	5
Leaving a net profit for the year of				*£176,685	2	9

* (The total of the monthly estimates of net profit, as published, was £175,310.)

This amount, added to the balance brought forward from last year, gives an available total at the credit of profit and loss account of £265,736. 18s. 8d. Three dividends amounting to 75%, or £165,458. 11s. 0d., were paid during the year, leaving a credit balance of £100,278. 7s. 8d. to be carried forward to the current financial year.

The total ore treated was 112,853 tons for a recovery of 111,337 oz. of fine gold, averaging 19·73 dwt. per ton, and 7,615 oz. of silver; in addition, 681 oz. of fine gold were recovered from sundry sources. Compared with the previous year, there was a reduction of 24,141 tons treated.

The Cote d'Or reduction plant was closed down in December last for reasons which have been previously indicated. The total tonnage treated was therefore smaller but, by dint of treating a larger proportion of Obuasi shoot ore, the outputs were maintained at the accustomed standard. As there was no increase in the total expenditure, the rate of profit-earning was also maintained, although the cost per ton shows a further increase. Gold production has, in spite of many difficulties and drawbacks in existing working conditions, proceeded without any serious interruptions, and outputs and profits have fulfilled expectations. The ore reserve position, notwithstanding a slight drop in grade, again shows an improvement. The ore in sight on September 30 is estimated at 534,100 tons, of a gross value of £2,772,000 and a profit value of £1,131,000—showing increases, as compared with the previous year's estimate, of 97,500 tons, £459,000 in gross value and £63,300 in profit value. These estimates allow for a higher rate of cost than in previous years, consequently the increase in profit value, although a very substantial one, is small in relation to the increase in gross value. The metallurgical results have been satisfactory. During the current twelve months the accustomed rate of profit-earning should be maintained without any difficulty which can at present be foreseen.

In accordance with the Articles of Association, Mr. Jeremiah Colman, one of your Directors, retires and, being eligible, offers himself for re-election. The Auditors, Messrs. Turquand, Youngs & Co., retire, and offer themselves for re-election.

HORACE MORGAN,
Secretary.

London, December 4, 1917.

EXTRACTS FROM THE REPORT OF THE CONSULTING ENGINEER, MR. W. R. FELDTMANN.

The net result of considerable additions of relatively low-grade tonnage at the deeper levels and of stoping the higher grade ore at and above No. 13 Level stopes is that the Obuasi Shoot reserves show a material increase in tonnage and gross value, with a small decline in grade. The following are comparative figures for the reserves in the Obuasi shoot:

Tonnage.	Assay dwt.	Gross Value.
	September, 1916.	
327,600	29·9	£2,077,000
	September, 1917.	
419,100	28·4	£2,524,000

Having regard to the fact that no ore is here included in respect of No. 18 Level, and that lateral development may, therefore, reasonably be expected to replace the equivalent of the tonnage stoped during the coming twelvemonth, it seems advisable to take advantage of an opportunity to economize in stores and material by suspending shaft-sinking for a time.

At the Central Treatment Plant 114,711 tons of ore were dry-crushed, roasted and cyanided, for a yield of gold valued at £480,376, or at the rate of 83·75s. per ton treated. The ore crushed consisted of 86,276 tons from Ashanti and 28,435 tons from Ayeinm. The mean residue value was 5·81s. per ton, on the basis of raw ore weight, showing an extraction of 93·5% as against 92·4% for the previous twelvemonth. At Cote d'Or Mill, which, for reasons already explained, only ran for three months, 1,906 tons of Old Chief and 266 tons of Big Blow ore were treated for a yield of £3,535—or 32·55s. per ton. The residue averaged 4·11s. per ton, showing an extraction of 88·8%.

The future monthly output programme indicated is as follows:

7,000 tons from Obuasi shoot (upper section) yielding	£37,300
2,500 tons from Ayeinm ,,	4,000
	£41,300

The usual allowance is here made for dilution in stoping and losses in residues.

GEEVOR TIN MINES, LIMITED.

Directors : Oliver Wethered *(Chairman)*, B. H. Nicolson, J. A. Stoneham, J. Vivian Thomas. *Secretary :* E. J. Andrews, 4, London Wall Buildings, London, E.C.2. *Formed* 1911. *Capital :* £60,000 in shares of 10s. each ; debentures £25,000.

Business : Operates the Geevor tin mines, near St. Just, West Cornwall.

The fifth ordinary general meeting was held on November 30 at Winchester House, London, E.C., Mr. Oliver Wethered (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report for the 15 months ended December 31, 1916, said he must first express regret that the meeting was being held so late in the year, but there had been a large and most exacting programme of development and equipment to be carried out, taxing their manager and his depleted staff to breaking strain, and making considerable demands on himself as managing director. For several years they had been developing the Geevor mine, and the expenditure, including capital actually subscribed and obtained from and again put back into the mine, amounted to over £200,000. There had been years of sowing, and but for the war the reaping would have come three years ago. Tin was the last of the base metals to respond to the heavily increased cost of mining it, and for a time development work was in a large measure suspended. Happily, May 14 last found them in a position to undertake this vital work, and he wished to pay a high tribute to their manager and his men for the speed with which this work had been carried out. When some years ago they sunk the shâft and put in a long cross-cut they employed the services of a well-known contractor from South Wales, but he was proud to say that on this occasion the whole of the work was being done by Cornishmen and solely under the supervision of their manager. It was rapidly approaching completion, and a very short time should find them with several years' ore reserves for the mill without the necessity of sinking another foot. But it was the ambition of their manager, Mr. Williams, and the board to create such necessity by increasing the milling capacity to 300 or more tons per day, and they were also anxious to see the lodes at greater depths, feeling every confidence that the width and length of the ore-bodies and the quality of the tin would improve as it had done at each level since they started operations. The lowest level was only 789 ft., compared with 3,300 ft. at Dolcoath, 1,440 ft. at East Pool, and 1,560 ft. at South Crofty, and two at least of these mines at that great depth were really now giving wonderful results, and the best authorities saw no reason why tin should not be found at greater depth. This was very satisfactory to them, because they had opened up at these comparatively shallow depths such large reserves. The completion of their present programme of development meant that the large number of men and drills would be employed in driving levels on ore to provide the present mill and the additions which were already in hand. The existing mill had only been running at about 75% to 80% of its capacity owing to the want of miners and the necessity of winding large quantities of rock resulting from sinking and cross-cutting in the granite. They hoped, however, shortly to be running the mill at full capacity, and the results would be very noticeable in the quantity of tin sold and also in the general costs.

He was glad to take this opportunity of referring to the relationships between the board and the representatives of labour in the district. Hitherto there had been no trade unions so far as mining was concerned in Cornwall, but during the last few months there had been considerable activity in this direction, and some correspondence was started in connection with their property by the Dockers' Union, for labour in their particular district came under the influence of that organization. It was quite evident that correspondence would not lead to any practical result, and a meeting was, therefore, held at which he and the local director, Mr. Vivian Thomas, with Mr. Williams, the manager, met Mr. Dan Hillman, the Union's local representative, and they had a very interesting discussion. At a subsequent meeting, when Mr. Wilkinson, the organizer, was also present, they came to an agreement which was equitable. Mr. Williams reported that there was evidence that the arrangement had given general satisfaction, and was in the interest of all concerned. The men were now working longer hours and were carrying out a stipulation which they ventured to make, and which the local representative of the union practically said should be carried out, namely, that, if the men were going to work underground 8 hours, 7½ of those hours should be efficiently employed ; that there should be no loitering on the surface or leaving at unduly early hours.

From the information given in the report, shareholders would be satisfied that they had a property of very great value and practically only in its infancy. It was satisfactory to know that the high view entertained by Mr. Williams and by all who had studied the Geevor position, was endorsed by Mr. J. M. Iles, the manager of the Rayfield (Nigeria) Company, who, when on a holiday in England, spent a considerable amount of time on the property. His conclusions were that with certain development expenditure and equipment, some of which was already carried out, and all of which would be carried out before many months, they should make very large profits on their capital with metal at £180, whereas to-day it was £290, or £110 more. Another engineer of great experience was allowed to visit the property, and his conclusions were most favourable to the mine, and he had expressed the view that a life of 50 years might confidently be expected for the Geevor mine.

Shareholders would no doubt be anxious to know what was the position at the present moment, because admittedly the accounts now presented covered a somewhat ancient period. Their returns from tin were very considerably up in comparison with the first ten months of the period under review. In the early months of the year, owing to the difficulties of labour and material, their output was small, but in the last few months the output had gone up very materially, and it had been substantially helped by the price of tin. Their last sale of tin, which was weighed in by Mr. Williams at the smelters on November 29, would produce something like £2,300, which was a result of fourteen days' ore only. If they were able to run the mill for full time instead of 75 to 80%, that figure would have approached £3,000. They had been much handicapped by having to carry on development work. There was no middle course; it was absolutely necessary; and he was glad to say it was rapidly approaching completion. The shaft was down to its full depth. They had put out a cross-cut to the south, which at any moment could be extended to cut lodes to the south. To the north the cross-cut was being rapidly carried out, and from two to three months would see the cutting of the South Pig lode, and a little after that they should cut the North Pig lode; and taking only two of those lodes and only estimating the same length at that level as they had had in the 5th level (and each level showed a longer length of shoot), they would have in the neighbourhood of 150,000 tons of ore. This in itself was eminently satisfactory.

They also undertook some diamond drilling. This was admirably carried out by the Sullivan Machinery Company, of Chicago, and they located certain lodes which were known to them and discovered two more, which might some day by cross-cutting prove to be of importance. But the crowning result of their efforts was that they cut what they hoped and believed was an extension of one of the famous Levant lodes, but what they modestly considered to be for the moment the north lode. That was a parallel lode standing to the north of the main workings, and happily very approachable by two drives, the 5th and 6th western drives on the North Pig lode. Mr. Williams and he went into the question of putting in cross-cuts from these two levels, but happily he found on examination that the lodes themselves or branches of them were turning toward this north lode. In Mr. Williams' opinion any hour any blast might carry one or both of these into that lode. If so they would have reserves which he, as a well known optimist, hestitated to put any figure upon, but they would be very big, and in any part of the world but their own would create something of a sensation.

With all this ore opened up it was naturally asked how they could get more machinery to deal with it. Fortunately they had four stamps which they took the opportunity of buying some years ago. Mr. Williams was ever on the look out for machinery, and with a very little good fortune when labour was available, and perhaps one or two Government permits for special steel and so on given them, he thought they would be able, instead of having four head of stamps dealing with 80 to 100 tons, to get eight heads running, and then with their small capital of £60,000 they ought to make very handsome returns.

With regard to the redemption of the debentures, the amount was not very large, and the conditions were not onerous, but in the ordinary course they were due for redemption at the end of the year. They were held mainly by people more interested in the shares than in the debentures, and if it became necessary they could at once renew them for a further five or ten years. But he had in mind, and Mr. Williams had in his mind, something which would be far more to the interests of the shareholders and to the whole district, if only the Treasury would take a reasonable view of the situation.

All these riches they were opening up were on the west side of the main road running from Penzance to St. Just. The country rose very rapidly into what was known as the Wheal Carne section. They were not getting an ounce of ore from that property, but there were no less than 13 levels by different headings going into that valley having values of 100 lb. of tin to the ton, which would be highly remunerative with tin either at its present price or many pounds lower. Here was a property in which, if the Government would allow them to provide capital, the conditions were such that when the war was over they could find employment for hundreds of miners, and employment would be a very grave necessity. He was, therefore, making an application, with, he hoped, a good deal of influential backing, to get the Government to allow them to use as the machinery a company which was registered nearly five years ago. It was called the Geevor Extended, and was registered for the express purpose of developing that property, which was not in the original lease, but was subsequently taken up. If they could get that permission, the Geevor Company would have the whole of its debentures paid off, ample capital for development would be provided, and it would be very largely to the interests of the shareholders. He was very hopeful they would be able to arrange it.

There was one other point, and that was the growing interest and appreciation which men of influence and knowledge were showing in Cornwall. He referred more particularly to that department controlled by Sir Lionel Phillips, famous in South African mining. He was Controller of the Minerals Development Department, the object of which was to develop minerals in the British Empire, and so make them independent of shipping should any such crisis as that they were now going through ever arise again. He visited Cornwall and invited some of those prominently connected with mining to attend a meeting at Redruth. Sir Lionel considered very highly indeed the value of the Cornish tinfield. He was not content to let that remain as a mere expression of opinion; he came to the conclusion that what had been done in South Africa by the cyanide process could be done to the same extent in Cornwall in connection with the recovery of tin. It was admitted that after many years of strenuous work the best ore was losing 30% of the tin contents in Cornwall, and in a company like theirs if they could get anything like 90% or, as Sir Lionel hoped, 95%, the ratio of profits would be increased enormously. They could afford to pay better wages, and it would be most satisfactory all round. He, therefore, decided to start a research department. He (Sir Lionel) summoned a meeting in Northumberland Avenue, where a very large number of people connected with tin and Government departments were present. He proposed a resolution to the effect that it was highly desirable to raise a fund of £5,000, of which the Government would contribute £2,500 if the mine owners and mines would provide the balance. Ten days later a meeting of the Cornwall Chamber of Mines was held. Viscount Clifden presided, and, in the way he had always so loyally supported Cornish mining, offered to contribute £250. Others agreed also to contribute, and that fund of £5,000 was now guaranteed. At a very early date he hoped research work would commence, and without expressing too optimistic a view, he was quite sure some good results would follow. It was a great point that a man who knew things and had done things like Sir Lionel Phillips should see the vital importance of the Cornish field to the nation, and he ventured to think that in the next few months—certainly the next few years—Cornwall would come into its own, and, instead of having a scattered mining population of a few thousand, would have many thousands.

Mr. John A. Stoneham seconded the motion, which was unanimously adopted.

RAYFIELD (CORNWALL) TIN SYNDICATE, LIMITED.

Directors : Oliver Wethered (*Chairman*), H. C. Godfray, J. C. Gould, B. H. Nicolson. *Secretary :* George Kerr. *Office :* 54, New Broad Street, London, E.C. *Formed* 1912. *Capital :* £75,000 in 5s. shares.

Business : The financing and development of tin properties in Cornwall.

The second ordinary general meeting was held on December 11, at Winchester House, Old Broad-Street, London E.C., Mr. Oliver Wethered (Chairman of the company) presiding.

The Secretary (Mr. George Kerr) having read the notice convening the meeting and the auditors' report,

The Chairman said : The very kind way in which some shareholders have verbally expressed their views and the considerate way in which the Press has dealt with the very long and unusual period covered by the reports, is, I need hardly say, very gratifying to me and my colleagues, because we all admit that there can be no justification for having accounts covering a period of four years unless the conditions are bad or of an exceptional character. In this case I think they have been of a very exceptional kind. The company itself started, I think, under excellent auspices, with the advantage of having Cornishmen on the board. We acquired a number of properties of great potential value, and the whole of our share capital was issued for cash. At that time, unhappily, the Canadian Pacific and all sorts of other securities were being sold ; tin was being sold at something over £200 a ton and came down to £120, with disastrous results. It has taken four years to bring about the state of affairs presented in the accounts. I think I can sincerely say that the position to-day is a good one—not only are the immediate prospects good, but they are very great. I will try to indicate what these are. One point I will deal with at once. In a comment in the Press the gentleman who wrote the financial article or criticism of our company referred to the fact that we had received £1,434 by way of fees, and assumed that was for one year. In the first place, let me state that it covered a period of four years, and, secondly, at that date only £100 of that amount had been drawn, and I may tell you that not one halfpenny has been received in respect of the guarantees. I do not think anybody would say we have helped ourselves unduly.

This meeting might have been held a few weeks earlier if we could have persuaded the Treasury to have allowed the issue of £15,000 additional capital, which would practically have wiped off all our liabilities. Negotiations went on for a considerable time. We informed the authorities that one large shareholder was willing to provide £15,000, with an underwriting commission of 5%, and that the shares should be offered pro rata to the shareholders. It seemed to me a most excellent proposal, one equitable in every way and greatly to the advantage of all concerned. But the Government have made up their minds beyond all question that money was to be provided for the war and war alone, and the application was refused. So far as we shareholders are concerned, perhaps it was a blessing in disguise, because our shares to-day are at a considerable premium. We have had no commission to pay, and, without any considerable sacrifice of our assets, to-day we are practically free from debt.

The position as I see it in Cornwall to-day is twofold. First, the immediate, as represented by the assets of Porkellis and Geevor, and the more distant future, as represented by the Zennor, Killifreth and other interests. Taking Porkellis, that is a property which was owned by this company, and as it was unable to carry on its development I was very glad to secure the co-operation of Mr. Janson, of Messrs. Tarbutt and Son, and Mr. Arthur Thomas, the manager of the Dolcoath Mine—than whom there is no finer judge of a mine—to join with me and a gentleman in Sheffield in putting up the working capital. A large amount of money had been spent and much work had been done, but it required a few thousands to be spent on development. It has been spent under the supervision of Mr. Thomas, with the result that the figures stated in the report of £100,000 profit in sight would to-day, if the Government gave us facilities to market the ore, represent something more like £150,000. Each week we are developing fresh ore-bodies, and in a few weeks we shall hear the mill is running. The first shipment of tin was actually made on December 10, but that was the result of cleaning up old ground in connection with the installation of the plant. That mill has not approached the capacity of the mine, but within the last few weeks I have been fortunate enough to buy an adjoining property—a considerable freehold, with two leases, and a mill which has a capacity of practically twice that on the Porkellis mine. If it can be so arranged, it is my desire to turn over the whole of that area and plant to the Porkellis Company. If that is not possible, then at all events the mill, which is in excellent condition, can be started very quickly, and will before long be crushing Porkellis ore. Another matter in connection with Porkellis is with regard to the extension of the lease, which had about fourteen or fifteen years to run. I am glad to say that we have now a lease of fifty years from March 25 last. We have some additional ground, and I think we may safely look to Porkellis being one of Cornwall's premier mines at a very early date.

With regard to Geevor, I see many gentlemen in this room who know a very great deal about it. We had ten days ago a very interesting meeting of that company, and with the report of these proceedings, which we propose to send out to the shareholders, we will include the Geevor report, giving some interesting information in regard to that property. That it is an excellent one may be judged from the fact that, notwithstanding limitations in the way of labour and materials, we are selling about £1,100 to £1,200 of tin every week. I should mention that at Porkellis we are only some five miles from the wire line of the Cornwall Power Company, which means that we can get additional power with a minimum of outlay.

We come now to the more distant future. On the Zennor property—which we own jointly with the Rayfield (Nigeria) Tin Fields—we have spent large sums of maney. We have a mill which would take very little to put in order, but we are in the position that labour is not easy to obtain, and until some action is taken by the Government we shall have to postpone any extensive mining operations. From careful study of the dip of the lodes and their extension we came to the conclusion that it was very desirable to acquire the adjoining areas. Thanks to our legal representative, a man of very considerable influence, Mr. Vivian Thomas, of Penzance, after months of negotiation we have acquired additional areas. which make the properties four times their original size, and included therein, I am told, is a very valuable area of china clay. Happily, we were able to get these properties by a very small expenditure, and dead rents do not begin to run until one year after the war, so there, I think, is an asset of great potentialities. In the next few weeks we shall start drilling and hope to show the best points in the numerous lodes if we obtain the necessary labour.

Of Killifreth, those of you who know Cornwall may remember Killifreth ran for some time and only had to close down when metallic tin fell to the extraordinary price of £67. 12s. 6d., while metallic tin to-day is £296. We had taken in hand before the war broke out the provision of a pumping plant, winding engines, etc., for that mine, but it involved very considerable expenditure in the way of fuel, and labour was very difficult to get, so that property will have to stand over. With regard to the other properties, the North Dolcoath mine, as stated in the report, is equipped with pumps and winding engines, and is ready at any moment to cross-cut the lode when labour is available.

These properties in themselves—those which are producers and those which will be big producers—represent an asset which in ordinary times would be extremely valuable, but I venture to think that from the point of view of those of us who are interested as shareholders they have largely increased in value in the last few months—I might say weeks—by the attitude of the Government in connection with the Non-ferrous Metals Bill, and that, in conjunction with the department controlled by Sir Lionel Phillips for the development of our mineral resources, the Government have come to the conclusion that the losses, which amount to 30% in the case of metallic tin in Cornwall, should be mitigated, and some think they should be reduced to the amount of the gold losses in South Africa, thanks to cyanide. If that is so it will mean thousands in our pockets. A committee was formed, of which I have the honour to be a member, and we provided £2,500 in Cornwall, the Government providing a similar sum, and research work will be started at once. But I do not think that the Government will stay at that. They realize that to have a large mineral area within 12 hours of London, where there is no question of U-boats or of high freights, is an asset well worthy of support, and I look with great confidence to seeing during the next few weeks some action on their part which will enable us to obtain more labour and greater facilities for materials. That in itself is very satisfactory, and but for the difficulties that have arisen the Government would not have taken this action. Having once taken it I am confident that they will arrive at the conclusion—some of us arrived at it years ago—that tin, of which 75% is controlled by the British Empire, is a national asset of the greatest importance and one that it is very desirable to develop.

We at the moment are only dealing with Cornwall, and we have in connection with that county formed the Cornish Chamber of Mines, of which Lord Clifden is Chairman and I am Vice-Chairman, and I want to appeal to those shareholders in the room to become members of that organization. It only costs a guinea per annum, and from that source you would be able to get interesting information and, at the same time, you would at a small cost be helping on a great British industry. Well, gentlemen, I do not think there are any other matters with which I can deal; but if any of you wish to ask any questions I will answer them to the best of my ability. I wish to thank everyone for the consideration shown in waiting such a long time for the report. I stated in the circular which I thought it necessary to send out that if it had been held earlier it would have inevitably led to liquidation, and that at the best would mean an assessment, and an assessment is a thing that none of us desires to pay; but improved conditions, good luck to some extent, and hard work to a still greater extent, have brought about a state of affairs that, instead of an assessment, you have shares standing at a premium. Of that I am very proud, and I am sure you will all be glad. I now beg to propose that the report and accounts be received and adopted. I will ask my old colleague Mr. H. C. Godfray, who, as usual, has stuck to me in the most sportsman-like way throughout, to second the resolution.

Mr. H. C. Godfray, in seconding the resolution, said he wished to take the opportunity of expressing on behalf of his colleagues the deep obligation they were under to their Chairman for the position to which he had brought their company. Some shareholders knew it as well as the Board, but there were no doubt some to whom it was news. Mr. Wethered's exertions would be extraordinary to one in good health; but when it was remembered that he had suffered during the last four years from continual ill-health, and had taken constant journeys to Cornwall on behalf of the company against the express orders of his medical man, shareholders could easily imagine what determination there was in his mind to protect their interest to enable him to overcome the weakness of the body.

The resolution was carried unanimously.

The Chairman next proposed the re-election of Mr. J. C. Gould as director.

Mr. Roughton seconded the motion, which was carried unanimously.

Mr. Gould, in returning thanks for his election, said that he considered it an honour when Mr. Wethered invited him to join the Board of the company. He had come to the conclusion that Mr. Wethered had obtained results far beyond the expectation of any ordinary person and had achieved these results in the face of enormous difficulties.

The Chairman next proposed the re-election of Mr. H. C. Godfray as a director. Mr. Jackson seconded the motion which was carried unanimously.

Mr. S. P. Derbyshire proposed a vote of thanks to the Chairman and directors for the way in which they had conducted the business of the company under very trying circumstances. One of the financial papers stated the other day that the report which the shareholders had received was a most dismal and disappointing one. He ventured to say that that depended on the point of view from which the shareholders looked at the report. If they looked backwards and saw the difficulties which the directors had had to face, then he agreed that it was a dismal state of affairs; but if they looked forward to the light he thought there was a bright future for the company. He wished to express, on behalf of the shareholders, the deep gratitude they felt to the Chairman for the work which he had done.

The motion was carried unanimously, and the proceedings then terminated.

BERRIDA (NIGERIA) TIN FIELDS, LIMITED.

Directors : S. R. Bastard (*Chairman*), F. N. Best, T, Carmichael, H. G. Palmer. *Consulting Engineers :* C. G. Lush & Son. *Secretary :* F. H. Pollexfen. *Office :* Friars House, London, E.C.2. *Formed* 1912. *Capital :* £175,000.

Business : Was formed to acquire alluvial tin properties in Nigeria, but owing to unsatisfactory results these have been abandoned. The lease has recently been acquired of the Poldice tin-wolfram-arsenic mine in Cornwall.

The fourth ordinary general meeting was held at Winchester House, London, E.C.2, on December 12, Mr. S. R. Bastard (Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1916, said that they had no property in Nigeria other than plant and machinery, which was not easy to realize, even if it were desirable to do so, as should Mr. Hannam, their consulting engineer in Nigeria, secure another property, they might very possibly require them for their own use. He was fairly confident that Mr. Hannam would secure another property, and should he do so he was equally confident that it would prove to be of value.

He now came to the Cornish property which the company had secured. In the course of this year it was brought to their notice that by means of fluted roughened glass a much larger quantity of material could be treated, and much larger percentage of mineral recovered than by the ordinary round wooden tables now in use, and with their new director, Mr. Best, he visited Poldice and inspected the glass-surfaced tables at work on a part of the property now owned by them. At this time the remainder of the property was under option to other people, and beyond seeing that an enormous quantity of dump or tailings existed, he took very little notice, though he was assured by Mr. Martin, their present metallurgist, that the property was of immense value. The results of the glass surfaces seemed so striking that it was determined to try the experiment on the tailings of the Red River in Cornwall, and three tables were coated with glass at the Gwithian Works, the property of the Cornish Tin Sands. To conduct these experiments he asked Messrs. Costin and Pope, two of their engineers from Nigeria, to go to Gwithian and see the experiments through. This they did, and both of them were thoroughly satisfied with the results obtained. While in Cornwall they visited Poldice and carefully examined these dumps, and both of them advised him to secure it, stating that in their opinion it was the best mining proposition they had seen. Subsequently they had a large number of vannings made from all over the property and in no instance did these fail to show a large tongue of tin and wolfram. Mr. Carmichael and himself had both personally seen a number of vannings made and the results of these fully confirmed the reports made. Mr. Carmichael, of the firm of Dent, Palmer & Co., who had had a large mining experience, was very favourably impressed with the property, and in proof of this he and his partner, Mr. Palmer, had joined the board and had made considerable investments in the shares of the company.

This property consisted of two propositions, one the dumps, the other the mine. The dumps could be divided into two categories: (1) the old battery tailings, (2) the ore from the old workings discarded on account of its wolfram contents. Dealing first with the tailings, it was a difficult matter to estimate the exact quantity that would be found on this property, but they covered an area of 160 acres, and from reports of those best able to form an opinion it appeared that there were well over 2,000,000 tons, which ready mined was as rich as the material on which many Cornish mines were now working.

With regard to the Poldice mine itself, which was worked for over one hundred years and was closed down in 1883, not from lack of material, but on account of the low price of black tin which was then only £37 per ton, the mine below adit level was under water, but from the plans of the underground working it was clear that there were vast quantities of mineral left standing both above and below adit level, which would probably in the main be found to consist of wolfram in conjunction with tin, copper, and arsenic. The property had not been worked below the 1,200 ft. level, which might be counted in modern tin mining as only a shallow depth.

Without including either the Wheal Maid and Wheal Jewell Mines, also leased to this company, which were both excellent tin properties, Poldice mine itself was made up of a large number of more or less parallel lodes, some of which were very wide, so that a true apprehension of the mineral deposits was best arrived at by regarding it as a property worked laterally as a consequence of the existence of so many lodes within its limits.

The board had no intention at the present time of unwatering the mine but would confine themselves to opening up and examining the ore standing above adit level, which they were advised could be done at a very small cost. It was intended to confine immediate operations to the working of the dumps. These would be treated in the first place by passing the fines through a pulverizer, thence over glass-surfaced round tables, three of which were now being worked, and it was proposed to increase the number to 12 so soon as the glass surfaces could be procured, the 9 round framed tables having already been purchased. The product from these would be put through Cornish buddles and as soon as the magnetic separator was erected, the tin and wolfram would be separated by that plant. Their manager estimated that these 12 tables were capable of dealing with about 200 tons of dump per day. It was believed that these tailings carried 20 lb. of tin and wolfram to the ton in about equal proportions.

With regard to finance, the board had obtained a loan of £13,500 for 4 years at 6% per annum repayable as to the whole or part at their option on 7 days notice, the only further consideration being that the lenders should have the right during the continuance of the loan to take up the 70,000 unissued shares of £1 in this company at par, less a commission of 5% per share, and that no debentures should be issued. This, with the cash the company had in hand, rendered the board confident that they had ample capital to place this enterprise on a dividend-paying basis.

Mr. F. N. Best seconded the resolution and it was carried.

JANTAR NIGERIA COMPANY, LIMITED.

Directors: E. W. Janson, P. C. Tarbutt, Oliver Wethered. *Secretary:* E. J. Hayman. *Office:* 18, St. Swithin's Lane, London, E.C. *Formed* 1912. *Capital:* £60,000.

Business: Operates an alluvial tin property near Jos, Northern Nigeria.

The fifth ordinary general meeting was held on December 11 at the offices of the company, 18, St. Swithin's Lane, London, E.C., Mr. Oliver Wethered presiding.

The Chairman, in moving the adoption of the report and accounts, said that in view of the shortage of water in April, May, and June, and the subsequent very serious shortage of foodstuffs, everyone must agree that the results shown were extremely satisfactory. It was true that the costs had gone up some £5. 10s. per ton, the result of higher royalties and increased freights and insurance, but they compared most favourably with almost any costs on the field. As he stated at the last meeting, in giving their manager the fullest credit, which they desired to do, for economical and thorough management, they were distinctly lucky in having a property which lent itself very much to economical working. They had also areas which could be worked with great advantage provided water was brought to them, and with tin at its present high price—as to whether it was too high he would have a word or two to say later on—they had, acting on the advice of the manager, sent out pumps which would raise the water to the necessary level, and they would win tin from that source; but he thought it was well to indicate that the costs next year would certainly in respect of that particular tin, be considerably higher, and this must necessarily affect the average. The outlook for the coming year was distinctly good, and he was glad to say, so far as one could judge, it would be good for several years to come, because with tin at a vastly lower price than it was, the Jantar properties would pay, and pay very handsomely. Perhaps in that connection he might quote what the manager said with regard to the small reduction in quantity last year. He put it very neatly, thus: "The small reduction in the output for the year, in comparison with the previous one, was entirely due to causes referred to in a previous paragraph, and must not be taken as indicating any impoverishment of the ground worked." The causes referred to were those he had already mentioned—namely, the shortage of labour, or rather of foodstuffs for labour, which led to a shortage of labour, and the smaller rainfall.

Those shareholders who had attended previous meetings might look to him to say something as to the present position of tin, as he had always ventured to express his views on that subject, in which he took a very deep interest. At all events, he was going to burden them with a quotation from what he stated at the previous meeting, which was as follows:—"The price of tin has risen to £190, and many hold that, notwithstanding war conditions and the limitation of shipping permits, it will go to an even higher figure. Others dissent from this view, but all seem agreed that with peace conditions the demand will be enormous and that the price must increase. As one much interested in the Nigerian field and the Cornish tin mines, I hope, and indeed believe, that this will prove to be so. For some years I have ventured to state that our large control of the world's production constitutes a national asset of great potentialities, and I am not without hope that those in authority who could use this position for the Empire's good may some day share this view." It was, of course, extremely satisfactory to be in the position of making a forecast which proved to be correct, but, apart from that personal congratulation, he thought it was a matter of very great moment to all of them to see that the authorities were waking up to the fact that the Empire, possessing a control of 75% of the tin of the world, had an asset which was of ever-increasing value and must, if the necessity arose, become a very valuable fiscal weapon. His own view was that the Government could, and, he was pleased to say he believed they would, adopt this view; for in his own narrow circle, in which formerly one knew nothing about tin, there were now at least 100 who were following it closely and, he was pleased to say, supporting it, not only financially, but from the point of view of influencing, as he was trying to do, their Chambers of Commerce and other authorities.

It had been the policy, and would be the policy, of the board to build up the Jantar property so that they might have not only this and next year, but for the good years which people believed would immediately follow the declaration of peace, a property that would be a big, consistent and profitable producer. It would be quite possible for them to give instructions to very largely increase the output. When he said very largely, he meant certainly by a good many tons per month, but as they desired to get returns which were consistent with the amount of ore developed there, they would not, because of the higher price of tin to-day, adopt a course which would seriously affect the value of the property. As he had said, it was the policy of the board to build the company up to a permanent concern, with a very long life, and he was sure that in that policy they would have the shareholders' hearty co-operation. If they were giving very meagre dividends and carrying out that policy to their immediate detriment, shareholders might very truly say what had been said so many times before, "What has posterity done for us?" But they had declared, or were about to declare, the balance of a very handsome dividend for the year, and therefore, economically, and from every point of view, that policy was justified. Before he concluded his remarks he would like to say how much they appreciated the excellent work done by the manager and his staff, to whom he personally payed a high compliment. He begged to move:—"That the directors' report and accounts to September 30, 1917, be and are hereby received and adopted."

Mr. P. C. Tarbutt seconded the resolution, which in the absence of questions or comment was put to the meeting and carried unanimously.

The Chairman then moved that the dividend of 12%, making 25% for the year, be paid on December 20, less income tax. This was seconded by Mr. E. W. Janson and carried unanimously.

On the motion of Mr. Tarbutt, seconded by Mr. Janson, Mr. Oliver Wethered was re-elected a director. Messrs. Annan Dexter and Co. were re-appointed auditors, and the meeting terminated with a vote of thanks to the Chairman, directors and the staff, both in London and Nigeria.

JEMAA EXPLORATION COMPANY, LIMITED.

Directors: G. T. Broadbridge (*Chairman*), M. H. D. Beresford, Captain C. T. Watkins. *Assistant Secretary:* C. M. Swornsbourne. *Office:* 32, Sackville Street, London, W.1. *Formed* 1912. *Capital:* £15,700 in ordinary shares and £598 in preference shares, both of £1 each.

Business: Examination and development of Nigerian tin properties; developed the West Ropp and Kassa properties, which have recently been sold to a new company, the Kassa-Ropp Tin Co. Ltd.

The ordinary general meeting was held on December 10, at the Cannon Street Hotel, London, E.C., Mr. George T. Broadbridge (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, first gave a short résumé of the objects for which the company was originally formed. During the Nigerian boom of 1912 there was a good deal heard of the Jemaa district, on account of a supposed discovery of a tin lode or lodes, with alleged phenomenal results. Their company came into being at that time with the chief object of sending out an expedition to Northern Nigeria to explore and acquire any territory which, in the opinion of the engineers, was thought favourably of, more particularly in the same district and on the same run as the lode to which he had referred. A good deal of ground was taken up and exploration work carried out, but without any satisfactory results, and in the end was abandoned. This also happened with regard to the other ground which had been supposed to contain the lode, and which belonged to another prominent company. The company also interested itself in one or two other ventures, some in Nigeria, Cornwall, and elsewhere. Most of these interests, however, also turned out unsatisfactory. Moreover, tin had then had a very material fall in price. Then the chance arrived for the company to secure an option on two tin areas in Northern Nigeria, which are dealt with in the present directors' report—the properties known as the Kassa and West Ropp. When these options were secured, with what remaining funds the company had, engineers were despatched to the property, and a good deal of work in the way of pitting and proving was carried out, with the result that the properties certainly looked most hopeful. Then the war broke out, and the option which the company held ran out, but was eventually renewed, with the express condition that they could win tin from any lease granted, deducting from the realization the working costs, and dividing the surplus between the company and the owners—an exceedingly good arrangement for properties merely under option. They were ready to send back the engineer, but there was no money with which to do it. A certain number of preference shares were created, and, with the consent of the Treasury, offered to shareholders, and a portion of them subscribed for. This amount, £601, was very useful and enabled the engineer to return to the properties and recommence the necessary work. It was not to be expected that £600 was going to carry the company very far in the matter of development work, Government rents, and other attendant expenditure. One of the first things, therefore, to be done was to obtain another lease from which an output of tin could be obtained, so as to make the property self-supporting. This was applied for on the Kassa area and granted. A contract was then entered into for the production of tin, and output started and had continued regularly ever since. The difficulty in the first instance, however, was to finance the tin, pending transport and realization. This was got over by guarantees being given in respect to an advance, and thereafter matters were fairly easy. Before this further lease was granted the Government of Northern Nigeria required a guarantee for not less than £1,000. This was also provided, and the lease was issued. After it had been granted they obtained tin representing a net amount of over £5,000.

The directors were then brought in touch with another group who held adjacent properties, including water rights. Negotiations proceeded for some considerable time, and ultimately resulted in an amalgamation of the several interests, which Mr. Oliver Wethered was able to reconcile. In due course a new company was formed, known as the Kassa Ropp Tin Company, with a capital of £40,000, in 10s. shares. They held in that company 11,500 shares of the nominal value of 10s. each, and, in addition, out of the transaction the Kassa Company had also made several thousand pounds in cash. The Kassa Ropp Company was still getting a regular output per month, and for eight months had returned about 77 tons. An interim dividend at the rate of 5%, free of tax, had just been declared. Mr. J. M. Iles, the general manager of the Rayfield Company, visited the Kassa Ropp areas in July last and expressed himself exceedingly pleased with the properties, and estimated that at that date there was over £40,000 profit in sight and every appearance, with a little more prospecting work, of this figure being doubled, with still further possibilities. He further considered it a good dividend-paying concern. That was when tin was at about £200. It was now over £290. The net result of this business was that they had been enabled to discharge their indebtedness, which was considerable, and still be left with a few thousand pounds cash in hand, as well as the shareholding in the Kassa Ropp Company. It would interest shareholders to know that quite recently he had been successful in obtaining the Niger Company as an ordinary shareholder of the company at par, which he considered a very good thing having regard to the big stake which it had in Nigeria and its immense organization there.

Their company had quite recently acquired a 24 acre lease of a further tin area in Nigeria, in the Jemaa district, and according to the latest information they believed that work had been started on this lease. He was unable to give any detailed information regarding this new area, inasmuch as one or two mails which should have brought fuller particulars had gone down.

With regard to the accounts, he would say that as the original assets of the company proved a failure it had occurred to them to be only a correct and sound policy to write them off and get rid of them, and it was practically solely owing to that that a substantial loss was shown on the accounts. With regard to the 601 preference shares, it must be obvious that the retention of these was against the best interests of the company. It was proposed, therefore, later on to submit a scheme, probably on the basis of so many ordinary shares for each preference share held, and thus revert again to ordinary share capital only.

Mr. M. H. D. Beresford, C.M.G., I.S.O., seconded the motion, which was unanimously adopted,

NARAGUTA (NIGERIA) TIN MINES, LIMITED.

Directors: F. N. Best (*Chairman*), H. C. Godfray, John Waddington. *General Manager in Nigeria:* F. O'D. Bourke. *Secretary:* A. J. Culley. *Office:* Friars House, New Broad Street, London, E.C.2. *Formed* 1910. *Capital:* £175,000.

Business: Operates alluvial tin properties at Naraguta, Karama, Sho, and Korot, in Northern Nigeria.

The seventh ordinary general meeting was held on December 12 at Winchester House, Old Broad Street, London, E.C., Mr. Frank N. Best (Chairman of the company) presiding.

The Secretary (Mr. Albert J. Culley) having read the notice convening the meeting and the report of the auditors,

The Chairman said: The report and accounts have been in your hands for some days. As tin has for many months been realizing high prices, I should not be surprised if, from a shareholder's point of view, the small increased profit of £397 is not considered altogether satisfactory, and would, therefore, like to explain the position as clearly as I can before asking you to pass the usual resolution. Our tin concentrates yield about 70% of metallic tin, and the selling price for the year under review averaged £148. 13s. 2d. per ton. The total all-over costs amount to £120. 6s. 8d. per ton, which includes £11. 3s. per ton for railway freight and dock dues in Nigeria, £3. 11s. 6d. sea freight, £9. 14s. 10d. smelting and Liverpool charges, £9. 3s. 10d. per ton royalties, £5. 0s. 5d. insurance, £7. 7s. 6d. income-tax, £4. 4s. 1d. depreciation, leaving a profit of £28. 6s. 6d. per ton. There is no doubt that at least £15 per ton of the costs is directly due to the war, and when that is over we hope to bring them back to the normal. We actually received £10,100 more for our 520 tons than for last year's output of 580 tons, but this has unfortunately been practically absorbed by the following items of increased expenditure:—Native wages, £3,732; royalties, £1,287; insurance, £1,877; income-tax, £870; rents, £1,617; travelling and transport, £535. The increase in native wages is partly due to our having worked a larger area of poor ground (with a less yield per ton), and partly due to an inferior class of labour now obtainable for work on the daily wage basis. For this we have to thank the pernicious system of tributing now largely in vogue, it being only natural that as soon as the native is trained he will go where he can earn a few shillings per day instead of, say, 9d., and this means constant training of raw labour. Tributing is a wasteful and uneconomical method of mining, for the richer portions only of the properties are being worked and the remainder left. Apart from this, it is also very conducive to tin stealing, which is undoubtedly on the increase, and if the Government do not realize the danger and very quickly find a remedy I am afraid it will mean the ruin of a good proportion of the industry. The increase in royalties, income-tax and insurance are matters unfortunately beyond our control. In the past our policy has been, as you know, to work our ground, rich and poor alike, so as to get the best economic life possible, and from the figures I have given you it is evident that we have either carried our economic policy slightly too far, and must do as others do—work the richer portions of our properties—or the Government must adopt a wiser form of administration to ensure the full and proper development of the mineral resources in Nigeria. If we were working in Australia the total cost for railway freight, royalties and rent would be under £5 per ton, as against £25. 4s. 2d. per ton we are paying the Government in Nigeria, and considering the small profit made, I think you will agree there is plenty of room for a substantial reduction in the Government charges to enable the companies to build up a reserve whilst tin is fetching a good price. If we continued working as we are doing to-day, the company undoubtedly will have a very long life, and even if we are driven to work the richer portions of our properties only, I am confident we shall still have many years of profitable work before us. I earnestly commend the question of tributing, and the figures I have given, to his Excellency the Governor for his serious consideration.

A short time ago a shareholder wrote asking why our shares did not enjoy the same amount of appreciation as some other shares in the Nigerian tin market, which, I am afraid, is both a difficult and delicate question to answer. Not holding shares in other companies, and not having any interests in anything but our own properties, it may be we have not so much to talk about, and therefore do not come quite so much into the limelight; it is also a well known fact that as soon as a mining company becomes a dividend payer it is classed as an industrial enterprise and speculation in the shares to a large degree stops. There is one thing, however, in connection with this matter that appears to me to be somewhat extraordinary, and that is as soon as a dividend is paid the shares are marked down the amount of the dividend, or slightly more, on the principle, I believe, that the company, having paid that away, is worth that amount less. This I can understand where a company has not increased its holdings. This company, however, was formed to take up four square miles of land, and its capital fixed at £175,000. To-day we own four properties, totalling altogether about thirty square miles, and have paid away in dividends, including to-day's, £96,250, free of income-tax; have written off £36,958 for main leat pipe line and development work without increasing the capital by one penny, and we still have £38,500 in liquid assets, cash and tin, and liabilities which I estimate about £6,400, so I really cannot see that this principle should apply to this company's shares. I now beg to move: "That the report and accounts be and are hereby adopted," and will ask my friend Mr. Godfray to second the resolution. I shall then be pleased to answer any questions you may wish to ask.

Mr. Hugh C. Godfray seconded the resolution, and it was carried unanimously.

The Chairman proposed the re-election of Mr. Godfray as a director; this was seconded by Mr. John Waddington, J.P., and carried unanimously.

On the motion of Mr. Wright, seconded by Mr. Stevens, the auditors, Messrs. Newman Ogle Son and Grace were reappointed.

The Chairman then moved the payment of a final dividend of 5% free of tax; this was seconded by Mr. Godfray and unanimously agreed to.

A vote of thanks to the Chairman terminated the proceedings.

IRTYSH CORPORATION, LIMITED.

Directors: Leslie Urquhart (*Chairman*), R. Gilman Brown, D. P. Mitchell, T. Blair Reynolds, Major C. A. Reid Scott, Baron V. V. Meller-Zakomelsky, A. A. Davidoff. *London Manager and Secretary:* J. P. B. Webster. *Office:* 7, Gracechurch Street, London, E.C. *Formed* 1914. *Capital issued:* £1,424,637; debentures £500,000.

Business: Operates the Ridder and Sokolni lead-zinc-silver-gold mines and the Ekibastous coal mine in the Altai district, Western Siberia.

The second ordinary annual general meeting was held on December 11, at Winchester House, Old Broad Street, London, E.C., Mr. Leslie Urquhart (the Chairman) presiding.

Mr. J. P. B. Webster (London Manager and Secretary) read the notice convening the meeting and the report of the auditors.

The Chairman, in moving the adoption of the report and accounts, said :—It has always been our intention to present to you the accounts of the Russian companies together with the yearly accounts of the Irtysh Corporation in order that the shareholders may be better able to visualize the position, but the disorganization in the book-keeping department in Russia, consequent upon the labour and other troubles brought about by the revolution, has made it quite impossible to obtain the accounts in anything like a reasonable period. We have, therefore, been forced to send out the report and accounts in the same form as last year. The balance sheet of the corporation shows that with the exception of London expenses and our cash balance, the whole of the money received from debenture issues and sale of shares has been applied in advances to the Russian companies for the purposes of the capital programme laid down.

The Report of the Technical Committee which accompanies the report and accounts deals fully with the developments and operations at our properties in Siberia, and although I am sure that it has been well studied by shareholders it will not be out of place if I comment on the most salient features. You will note in the Technical Committee's Report a paragraph headed "Discovery of gold ore in Sokolni." It is a short paragraph but of extreme importance; in fact we have discovered in the Sokolni mine a belt of oxidized gold ore 200 ft. *wide* and averaging nearly 30 dwt. gold. While our engineers are not yet able to assign any definite length to this ore-body it would certainly seem reasonable to suppose that an ore-body 200 ft. wide must extend to considerable length and depth. As a means of visualizing the possibilities of this deposit a rough estimate of the ore above the present tunnel level which in the report is given as 140 ft. from the surface represents about 200,000 tons for every 100 ft. of length. You will realize from these few remarks that we have here an ore-body of already great value and of great future possibilities. The treatment of this ore presents no metallurgical difficulties.

The flooding of the Ridder mine, of which you were duly advised, forced us, pending its unwatering, to expedite the development and extraction of ore from the Sokolni mine. The developments at Sokolni have been most satisfactory, our work has proved very important new bodies of rich sulphide ore as high grade as the Ridder, and has increased our total ore reserves by at least another 360,000 tons of developed ore, not including any extension in depth, and has found for us the important new gold discovery and has shown us that the probable value of the Sokolni mine is at least as great as the Ridder mine. The unwatering of the Ridder mine can be taken up at any time we may consider that labour and other conditions permit; the mechanical equipment is now on the spot and the mine can be unwatered in at the outside six weeks. I would again mention that the ore being at present extracted from the Sokolni is quite as profitable as that from the Ridder, cheaper to mine, and more than sufficient to cover all our mill and smelter requirements for a long time to come without the help of Ridder.

While it would have been quite possible to have continued our drilling campaign to show up still larger reserves of ore, we considered it best in view of the ample reserves in sight that our Geological Department should concentrate its energies on a detailed geological survey of the mineralized belts on the Concession. This work has immensely increased the mineral possibilities as the map which has been sent you clearly shows. Five of the mineralized belts contain the outcrops of a number of deposits similar in character to Ridder; the belts are the same type but of much greater extent than that on which the Ridder, Sokolni, Krukovsky and our other known mines are placed. The sixth belt is similar in occurrence to the Kyshtim mineralized areas and contains several gold-bearing iron gossans which have now been conclusively proved to be the cappings of copper ore deposits.

You will expect me to say a few words about our ore reserves on the Ridder Concession. As no drilling work has been done for the past year the reserves of ore at Ridder mine remain unchanged, while there is an increase of 360,000 tons due to the opening of the Sokolni mine. Based on the pre-war prices of metals, the total proved ore reserves now show a profit value of £13,000,000, but no gold ore is included in this estimate from the new Sokolni gold find. I find it difficult to deal satisfactorily with this question on the basis of our proved reserves, as these serve as no measure or criterion of what we can confidently expect from our great mineralized Concession. It will require years of diamond-drilling work on our many known deposits alone to give any definite idea of this. In a word, the question of quantities of ore need never trouble us and the output can only be limited by our ability to handle and smelt it.

The remarks I have just made about ore at the Ridder Concession apply in the same way to the Ekibastous coal basin, the reserves of coal there being practically unlimited.

Summarizing the operations generally which have been described in detail in the Technical Committee's Report, I may say the concentration mill is sufficient for all our requirements for some time to come and has been giving excellent metallurgical results. The Ridder Railway, 70 miles in length, is now completed and in operation. The Ekibastous Railway has been further extended to a total length of 90 miles. The fleet and river transport is in the meantime ample for all our requirements. The coal mines are equipped and developed for an output far greater than the output which owing to labour difficulties we obtained this year, and when conditions are again normal there will be no difficulty in increasing this to meet all future requirements. There are two furnaces in operation at the zinc plant which have given good metallurgical results; additional furnaces of the same type as are now in operation are in course of construction. Since the date of the Technical Committee's Report we have news that the lead smelter has been started, is working satisfactorily, and is producing a valuable output of lead, gold, silver, and copper metals.

This great self-contained enterprise from the mining of the ore to the final extraction of its metals is now established. The metallurgical processes have all been proved, rail and river transport facilities provided, and the mills and smelter works generally fully equipped. We are now working on a commercial scale, only requiring additions to the different plants to attain large outputs and profits. You will realize that to have accomplished these magnificent results during the war required the unselfish devotion to our interests of everybody concerned in the management of our properties. Since the revolution the work of our directors, managers, and staff in Russia has been very often carried on under conditions of danger, with labour difficulties due to the political ferment which has demoralized the discipline of the workmen and has created endless troubles which our managers had to overcome. Notwithstanding these conditions we are all proud to say that we have not had a single day's stoppage at any of our works. I feel that we owe a deep debt of gratitude to our president in Russia—Baron Meller-Zakomelsky—and the directors and managers of our companies, and I am sure that this meeting will express its appreciation of their unselfish devotion.

The political and economical chaos of the last eight months in Euвopean Russia has naturally seriously affected and delayed our programme of construction work and the exploitation of the properties on the larger scale anticipated, but although the output at Ridder and Ekibastous is still small the income derived is considerable and is being applied for the purposes of our general construction programme. Notwithstanding the difficulties we had to contend with it will be some satisfaction to you to learn that the estimated recoverable values in metals and concentrates in stock at all points and mostly at the smelter approximate roughly Rs.20,000,000 at present market prices. Further, we have provided and transported all the fuel requirements of the Ridder mines and railway until the middle of 1918.

The large stocks of concentrates at the smelters and the provision of all fuel and other requirements at the mines for operations on a large scale has necessarily required the provision of considerable working capital, but this sound and satisfactory position ensures a large, continuous and increasing revenue to the Russian companies as soon as conditions permit of normal work. But for the present events in Russia we should to-day be making large profits which could have been employed in further construction work and in adding to the larger working capital required for the increased operations of our business.

Owing to the restricted operations of the zinc smelter at Ekibastous and the delay in starting the lead plant, the receipts from the sale of metals have been barely sufficient to cover all current working expenses, and while we have strengthened the business by continuing the construction programme and preparing and carrying all stocks necessary for operations on a large scale, this has required financial assistance from outside which, if the smelters had been working up to full capacity, the realization of the metal values in the concentrates we are carrying would easily have provided.

In times like these your directors were very loth to appeal to the shareholders to further support the company and we decided to make every effort to carry on in these difficult times and to bring the company to the profit-earning stage without asking the shareholders to take the burden on themselves, and I am glad to say we have succeeded in doing this.

I informed you last year that a long credit of Rs. 1,800,000 had been opened to the Russian companies by an important Russian bank. For some time past your directors have felt that the internal financial position in Russia was such that the foreign rate of rouble exchange was bound to go still further against Russia and that, therefore, we should gain on the exchange if we, in the meantime, financed in Russia instead of remitting monies from here. Immediately on my arrival at Petrograd in the spring of this year favourable arrangements were entered into whereby the credit of Rs.1,800,000 was increased to Rs.5,000,000. I am pleased to say that our enterprise is held in such high esteem in Russian business circles that we had no difficulty whatever in arranging this long term credit and further should it be necessary we have obtained assurances from more than one Russian bank that this credit can be still further and very largely increased. This is not surprising when one considers the vast metal resources of the Ridder and Kirgiz companies, and the fact that whatever the perturbations the politico-economical events in Russia may bring about, the zinc, lead, copper, gold, and silver metals which these companies produce have a world's market and standard values; the shortage of production generally and the enormous world's requirements in these metals both now and after the war naturally makes the future prosperity of these enterprises independent of the fluctuations which may affect producers of other commodities.

Now this credit sounds a very large sum, as at pre-war exchange it would have amounted to more than £500,000. Had we remitted the Rs.5,000,000 at the time we required it in Russia this would have cost us about £335,000. I am glad to say that by financing in Russia as we have done this credit will only require about £130,000 to cover, a saving to the company of over £200,000.

It was my intention to have given you a financial résumé of the operations of the Russian companies, but unfortunately the disorganization in Russia has prevented the completion of the necessary statements and, therefore, although I can give you no actual figures I can only repeat that the financial arrangements made in Russia provide with a margin for all requirements which can be reasonably foreseen at the present time and which make allowance for the present labour situation at Ridder and Ekibastous.

It is probable that with the lead smelter now in operation and the large additional revenue that this will now bring in, our financial position will be henceforward very sound and will be covered by revenue. In times like these, however, it is best to be prepared for the unexpected, and the arrangements with the Russo-Canadian Development Corporation, which I will define later, will show you that we have taken every precaution to further guarantee the financial requirements of the company against any possible eventualities.

As we are far removed from the centres of chaos and anarchy in Russia, 2,000 miles at least from Petrograd, these events have not affected us as seriously as other industrial enterprises in the country. Nevertheless, a reflex of these anarchist influences does reach and seriously affects the discipline of the Russian workmen, the relations of these workmen and the management, and the normal operation of our business. I would mention that at the Kirgiz properties the majority of the men are local Kirgiz Mussulmans who are peaceful and have caused no trouble of any kind

Immediately after the fall of the late Czar's Government the socialists and extremists formed at Petrograd what is known as the Soviet or Council of Workmen's and Soldiers delegates, and hundreds of local Soviets subordinate to Petrograd were formed all over the country. These Soviets were supposed to represent the working classes of the towns and the soldiers; these being simple ignorant men were naturally influenced and controlled by the Executive Committees of the Soviets composed of wild idealists, internationalists, pacifists, anarchists and the scum and pro-German traitors who came with them. At first the moderate socialists and pro-Russians were in control, but extremist influences continued to gain ground until to-day the Bolsheviks, a curious jumble of conflicting elements ranging from wild idealism to German intrigue and reactionary monarchism, not only control the Soviets, but have proclaimed themselves the Government of the country.

The Soviets, by preaching a furious doctrine of class hatred and plunder among the working classes and being liberally supplied with German money carried on an active peace and fraternization propaganda among the ignorant soldiers at the rear and front. The industrial workers and the soldiers were quickly demoralized, and as a result you have chaos in the country to-day. Political freedom was suddenly granted to 200,000,000 of people, the great majority of whom were ignorant and illiterate, politically undeveloped, used for generations to a Paternal Government with the Czar and Church to keep alive the consciousness of their spiritual being, their understanding of right and wrong, the ideals that kept them together as a people, the symbols and emblems of their nationhood. The ideals which they understood were replaced by sublime doctrines, by socialist theories, by rotten international trash which killed their love of country and pride of race, by the preaching of class hatred and plunder, by peace and fraternization propaganda, by German money and alcohol, by the mad ravings of demagogues and fools.

The untutored Russians, full of mystical theories, with childishly trusting simplicity, believing every lie they were told, every lying promise made, their childish ignorance made them the easy victims of the adventurers, demagogues and traitors.

The Russian Democracy is not ready for socialistic or republican self-government; the proletariat and peasants are too ignorant for independent political life. Personal rule is what they have been used to and a Paternal Government, in the form probably of a conservative Constitutional Monarchy, is what they understand, require and must have, but an anarchist Government had to come to drive that simple truth home to them. They have tried Liberty and misconstrued it into License, they have suffered too much and have already had enough; they are longing for that law and order which the proletariat of the towns, the ignorant demagogues and traitors who have jumped power, cannot and will never give them.

The present anarchist or Bolshevik Government is artificial and cannot last, and these absurd fanatics and traitors obtained control of the technical equipment of the country, the railroads, posts and telegraphs by pandering to the lower instincts of the town and industrial workers. But these people do not represent 10% of the population. The real Russia is the 85% living on the land, the peasant proprietor, the peasant communities who own communal lands, their own houses, cattle, food; they have a stake in the country to lose and when they at last understand, as they are rapidly realizing to-day, the real issues preached by the Bolsheviks, they will have nothing to do with socialistic and anarchist theories. I am sure that every shareholder present and indeed every Briton throughout the world will have seen with the utmost pleasure that the British Government had the insight and the courage to break off all relations with these opera bouffe usurpers.

The town, railway and industrial workers, thanks to the incitements of their anarchist leaders to work as little as possible for as much money as possible, have brought about the breakdown of the railways and as a result hundreds of thousands of factory workers are now out of work in Petrograd and other large towns as there is no fuel for the works. The proletariat have paper money in abundance but they cannot buy food as this has to come from the interior and Siberia and the railways cannot supply the towns. Famine is staring them in the face; the proletariat is being forced by nature to see reason at last. The demoralized undisciplined Army of 12,000,000 men is mainly drawn from the peasant classes and while many are loyal to their country and may remain at the front, many millions, mostly infantry, committing excesses as they desert, are returning to their villages for food, but they will there eventually come under the sobering influence of their elders and women folk at home.

To-day the governing issue in the settlement of the terrible crisis that Russia is going through is the question of food. In the districts where food is abundant as in the Ukrain, the Don, the country of the Cossacks, the Caucasus, the Urals and Siberia where all the properties of this group of companies are located, there is comparative law and order; I do not pretend that there are not individual excesses even there, but there are mainly due to deserting soldiery. You will already have noticed in the papers that these districts representing possibly 80% of the Russian Empire refuse to recognize the usurping Bolshevik Government at Petrograd and all it stands for. They refuse to supply them with food for fear it falls into the hands of the Germans; they are organizing a determined opposition and in the end they must win because they have nature, the great majority of the people, common sense and food on their side. The elections to the Constituent Assembly are gradually revealing the will of the nation. The latest election returns show that the Bolsheviks have 2,700,000 votes, but the Cadets, representing the intelligent bourgeois elements and the Revolutionary Socialists who are both opposed to a German peace, have each obtained over 2,200,000 votes, or together 4,500,000 votes, thus considerably exceeding the votes cast for the Bolsheviks. The action of the latter is characteristically despotic; they threaten to use force and other unfair means to suppress the meeting of the assembly representing the electors of the country, but it is very doubtful whether they will really venture the attempt. If they do the reaction against them will be the greater and quicker; they can never go against the will of the nation. The Bolsheviks are on the point of collapse; Russia is rising again; the country is coming back to common sense and the sufferings of the deluded masses this winter will finally complete their downfall and that of all other extremist elements—to my mind this is certain and bound to take place very soon.

In the earlier days of the Revolution a number of our employees both at Ridder and Kirgiz were arrested and driven off the properties by the local Soviet simply because they did not please the extremist leaders of the men. The majority of our workmen are moderate in their views and see the unreason of the Soviets but many are terrorized and submissive to the agitators who endeavoured by every means in their power to usurp the authority of the managers. The managers have naturally had great difficulties to contend with, but we are and have been fortunately in a position to prevent any further excesses for we provide our people with food and they realize that if they force us to close down they will starve.

The internal purchasing value of the rouble to-day and the wages paid are entirely dependent on the price of food. Wheat, meat, butter and other essential foods are plentiful in the districts of Siberia adjacent to the Ridder and Kirgiz properties. The Russian companies by purchasing large quantities ahead can do so at comparatively low prices, and by selling from its own stores at cost prices to the workmen keep down the price of essential food commodities. By this common-sense policy wages have been kept within very reasonable limits. During the four months of this summer when I was in Petrograd on the affairs of these companies, I had frequent opportunity of meeting and discussing political and economical questions directly affecting our enterprises in Russia both with delegations of our workmen and with the Ministries concerned. The extreme socialist officials of the new Ministry for Labour at Petrograd, and Skoneleff, a minister appointed by Kerensky, were if anything more extreme in their demands than the workmen themselves, and I can say that this Ministry during Kerensky's Government, instead of helping to moderate the appetites of the men, incited them to further increase their demands.

But all these are small matters; they have naturally given us great cause for anxiety and unlimited thankless work, but they will be very much in the past when the politico-economical happenings in European Russia to-day will by a simple process of nature bring about stable Government in the country, and I feel sure that ere this winter is past Russia will be herself again.

The peace question is much broader and more fundamental than that of the passing Bolshevik authority. The Russian people, the ignorant masses with famine staring them in the face amidst all the anarchy and confusion, an army demoralized by the promise of peace negotiations, are longing for peace; but in my judgment they are not going to agree to peace on Germany's terms. At the same time the prostration of Russia is a heavy blow for the Allies, but it would be a mistake if we allowed our feelings to endanger Anglo-Russian relations. The intelligent Russian classes are suffering the deepest feelings of humiliation and shame. The officers in the Army are martyrs to the Allied cause. But they are powerless in numbers to prevent what is happening. There are still many brave and loyal soldiers who can be depended upon when the opportunity comes to fight for the honour of their country and give their lives as they have done before. The saner elements in the population are slowly regaining influence and if, for the moment, Russia is out of the war she will continue to contain considerable German forces on her front and possibly later may be able to render considerable assistance.

There is a great deal going on in the real Russia but it cannot be told to the world just yet because the Bolsheviks at Petrograd are at the end of the telegraph lines. But there is no reason to be pessimistic. Nature must and is reasserting herself. I have lived in Russia for the best part of my life and I know and trust the real Russian people, and I have a certainty of conviction that Russia after all her humiliation, will rise again; her destiny marks her out for a great future; her natural resources, her immense population are security for this.

If we can show the Russian people that we sympathize and understand their terrible difficulties, if for the sake of all we have suffered and sacrificed together in the common cause we continue our moral support, we shall be repaid a thousandfold by a people who though temporarily misguided are generous and kind-hearted; if we judge them harshly we are only playing into the hands of our enemies.

There is a matter which I understand has caused anxiety to some shareholders and which it may be well if I mention, that is the question of the titles to the properties of the Ridder and Kirgiz companies. The Ridder titles, as you know, were granted to us by the late Tsar's Cabinet on a lease of 76 years and on a low royalty basis. The Kirgiz coal and other properties are held directly from the State until complete exhaustion under the usual mining leases and terms.

When the Tsar abdicated all crown lands became the property of the State; in other words, they were nationalized. The benefits and obligations of the Ridder contract, therefore, reverted to the State; no change was necessary in the lease of the Kirgiz properties as these properties already belonged to the State. It will be evident that as all these properties already belong to the State they cannot be subjected to further nationalization. The Bolsheviks or Anarchists, whose power is passing as Russia will have none of them, talk of expropriation in favour of the State. In our case there is nothing to expropriate except the leases; the properties themselves are not yet fully developed and equipped and require considerable working capital and besides capital special expert technical knowledge to operate. Neither of these conditions even if we take them seriously are the Bolsheviks or Anarchists able to fulfil; as a matter of fact, by doing this they would undoubtedly lose a source of revenue to the Government in the royalty the company pays. Apart from this, however, the negation of all property right is the negation of statehood and to my mind is inadmissible as history has never shown us such a precedent. Even the most savage tribes in the world recognize the right of the person and of property as necessary for their existence. The whole of Russian industry has been developed by foreign capital and enterprise, and Russia requires foreign capital to develop her unlimited natural resources; how is she going to get this if she turns herself into a robber State? It is more especially absurd, therefore, to expect that Russia, a country undeveloped, with few industries, a population of 200,000,000 practically untutored and politically undeveloped, 70% at least of whom are illiterate, is in a condition fit for socialist self-government and the carrying into effect of extreme socialistic measures. What is there to socialize, what is there to expropriate? Of the population, as I have already mentioned, less than 10% are factory workers, 85% live on the land and these have a stake in the country to lose. Only 10% are large landowners in European Russia, while Siberia is entirely owned by the State. The State cannot discriminate, and therefore legislation must cover everybody. If therefore, our properties are expropriated, then the whole of Russia must be expropriated, which is an absurdity. Nationalization? But our properties already belong to the State; any way you look at it I really cannot see any change can be made in the titles to our properties when a stable Government is established, and these absurd anarchists and traitors are put in their right place.

I now come to deal with the paragraph in our Report which runs as follows: "The urgent necessity for the adoption of prompt measures to uphold and safeguard British interests in Russian mining undertakings which British enterprise discovered and British capital has developed has been so forcibly impressed on your directors that they recently made arrangements which they believe will secure the object desired. The nature of these arrangements will be explained by the Chairman at the ensuing meeting."

I ought to say that exactly similar arrangements have been made by each of three companies, viz: this Corporation, the Kyshtim Corporation and the Tanalyk, all of which, as you know, are in many respects allied.

For several months past this matter has caused us great anxiety; we became aware of attempts in more than one quarter to purchase blocks of shares in some of the group of companies I have mentioned, in order to acquire control and apparently to substitute foreign for British influence as the determining factor in the policy and administration of our Russian enterprises in which so large an amount of British capital has been invested. It is interesting to observe that only last week the "Frankfurter Zeitung" had leading articles on the 23rd and 26th November on the value to Germany of our properties. Only recently has this country recognized and appreciated the vital importance of metal production to a country's well-being and the power which such a control would give to foreign interests; and the British Government, to judge by recent legislation, are now fully alive to the urgency of the question, and it goes without saying that this company will use every endeavour to assist them in solving it. In taking up the question in March last we felt confident that we should have the unanimous support of our British shareholders if we, on our part, succeeded in evolving a scheme to render futile such attempts as had been made, and will undoubtedly be repeated, to secure for foreign interests the control of these metal industries in Russia.

The problem before us was in what way we could secure that British interests alone should continue as the predominating factor in the working of our properties and the sale of their products. It had to be recognized that as things stood the direct or indirect acquisition of our shares on the English or foreign stock markets might at any time secure foreign influence to the prejudice of British interests; our object was to render such influence impossible, and in consultation and co-operation with our largest shareholders and with financial houses of the highest standing in the City, the scheme which I will now proceed to explain in detail was evolved.

I will deal with the particular arrangement made by the Irtysh Corporation which I will call "this Corporation"; the Ridder and Kirgiz Companies I will call "the Russian companies," and the shares of those companies "the Russian shares."

The first point was to vest the Russian companies' shares in a British company in such a way that even if the majority of the shares of this Corporation got into foreign hands, yet the influence in controlling the business should remain British. We therefore arranged that the Russian shares should be vested in the Russo-Canadian Development Corporation, Limited, a company which is operating in Russia and which has a cash capital of $2,500,000, now being increased to $5,000,000 cash. This will be done with the concurrence of your debenture-holders trustees which we have no doubt will be readily accorded. I have myself discussed the matter with some of the largest holders of debentures who entirely support the scheme as being wholly in their interests. Thus the Russo-Canadian Corporation will be vested with the Russian shares and in exchange this Corporation will receive debenture stock of the Russo-Canadian Corporation specifically charged on the Russian shares; to the debenture stock is attached the exclusive rights whether to assets or to earnings which the shares of the Russian companies confer. Thus you will see that whilst this Corporation still retains its full beneficial interests in the Russian companies, the control ownership of those companies will be vested in the Russo-Canadian Corporation.

In addition to the shares in the Russian companies, this Corporation is a creditor of the Russian companies for advances, etc., outstanding, and these amounts will be exchanged for a second series of debentures of the Russo-Canadian Corporation to which series will be attached all the benefits, rights and security in respect to these advances. This Corporation will, therefore, in place of its present assets, hold two series of debentures in the Russo-Canadian Corporation secured by the Russian companies' shares and the debts due from the Russian companies respectively, and these securities will be held by trustees nominated by this Corporation. In other words, your assets are represented by the same identical assets, but these assets are held and administered for you by a British Corporation with a cash capital of £1,000,000. At the same time no interference by foreign interests is practicable, for, as I will explain, the control of the Russo-Canadian Corporation will be in British hands and in British hands protected from any exercise of voting power by a foreign and hostile majority were such a majority to come into existence through the acquisition by foreign interest of the majority of the shares of this Corporation. This is the all-important feature of the scheme and I will satisfy you that this has been secured.

The administration of the Russo-Canadian Corporation will be in the hands of a Voting Trust, a body of gentlemen principally composed of those who have been closely associated from the outset with this group of companies. I will give you their names in a minute. I may say that those who have subscribed £1,000,000 to the Russo-Canadian Corporation are prepared to leave the administration of that Corporation as well with this Voting Trust, and I believe you will have a similar confidence as regards your interests as shareholders in this Corporation.

The Voting Trustees are 15 in number, of whom eleven are either members of your own board or gentlemen who from the very first have been identified with the management of this group of English companies interested in the Russian mining industry. The names of the Voting Trustees are: Charles J. Cater Scott, Leslie Urquhart, Reginald Fellowes, R. Gilman Brown, Reginald Scott, T. B. Reynolds, H. A. Andreae, Edward Mackay Edgar, Baron Meller-Zakomelsky, Major C. A. Reid Scott, T. J. Jones, Herbert Gibson, D. P. Mitchell, William Mackintosh MacLeod, Raleigh Phillpotts. An Advisory Committee will be appointed by the Russo-Canadian Development Corporation and through this Committee the Irtysh board in London will be kept fully informed of all matters of interest in connection with the properties for communication to the shareholders from time to time. It may be said that your representation by this Voting Trust is not so satisfactory as representation by a board of your Corporation, who under the system of retirement by rotation and re-election by the shareholders are more effectually under the shareholders' control; but this power of the shareholders would, it will be seen, be the very method by which foreign purchasers of a majority of voting power would substitute foreign for British influence. The Voting Trust is a Perpetual Trust and no Trustees can be removed by any insiduous campaign or by any casual or chance vote. You will see that the large majority of the Voting Trust are British, a British company will own the Russian properties, and British influence will administer them. We believe the shareholders are prepared to trust those they have trusted in the past, to trust them to administer the properties themselves, and to trust the continuing Trustees from time to time as a Trustee dies or retires to appoint as occasion arises a fitting successor, and thus to ensure that British influence will remain as the controlling influence of the Trust, and be handed on without interruption.

We are satisfied that in the arrangements we have made your interests have been safeguarded, and that the development of the vast resources of these Russian properties will under these arrangements, which provide ample cash resources for all purposes, proceed (as soon as the present chaos in Russia is succeeded, as it must be, by a settled Government) smoothly and satisfactorily with constantly increasing profits, and that these profits will, through the Russo-Canadian Corporation, safely reach those whom I am now addressing, and all others who may hereafter become shareholders in this Corporation.

Hitherto I have spoken of the Russo-Canadian Corporation only in reference to these safeguarding arrangements, but your directors look on it as a powerful organization which with its £1,000,000 cash capital will be of the utmost importance in alliance with this group of companies. In these circumstances it is probable that some of you would desire to have an interest in the Russo-Canadian Corporation and we have, therefore, obtained the assurance of the directors of that corporation that the shareholders of this corporation will, when it is possible, have an offer to subscribe for its shares on such terms as we are able to arrange for you, and I feel sure that these terms will be satisfactory to you.

So far as regards this Corporation in particular I would say that many Irtysh Corporation shareholders are shareholders in this Russo-Canadian Company and I am pleased to say that not only will the Russo-Canadian Company hold our Russian shares, but they are so largely interested in Irtysh Corporation that they will not hesitate to use their large cash capital in safeguarding the interests of this enterprise. At the same time I would mention that the members of the Voting Trust individually own or represent between 600,000 and 700,000 Irtysh shares, and with the Russo-Asiatic Corporation (the majority of directors of which are on the Voting Trust) will represent more than 80% of the total issued capital of the Irtysh Corporation.

One other point I would mention in connection with the Russo-Canadian Corporation. You will remember I explained to you a year ago the circumstances under which I sought for and took up at my own expense certain properties in the Steppe districts. I would now inform you that as I did not feel justified in adding to the already considerable expense I had incurred, I made arrangements to hand the properties over to the Russo-Canadian Corporation for development and exploitation. I am glad to think that in securing for you an opportunity to subscribe to that Corporation I have been able to carry out the promise I made to you at our last meeting that you would be offered a participation in any business to which the development of the Steppe properties might lead.

I now beg to move: "That the directors' report, balance sheet and statement of accounts for the period ended January 13, 1917, now before you, be received and adopted."

Mr. R. Gilman Brown, E.M.: I beg to second that resolution.

The Chairman: Before putting this resolution to the meeting I shall be pleased to answer any questions the shareholders may desire to ask.

Mr. Francis Moore; I must say that I do not think I have ever been present at any public meeting where

I have heard a more remarkable and absorbing statement than that which has been made by our Chairman to-day. We are, as you are aware, living in wonderful times, and one of the matters referred to by the Chairman will have struck you, as it did me, as very remarkable. It was this, that in these times when Russia is passing through this great crisis, financiers in the City of London should have raised one million sterling with which to carry on the great work upon which we shareholders have been engaged in Russia for some years past. That, to my mind, is most remarkable. You have heard the inspiring and lucid statement of our Chairman, which constituted a very fine exposé not only of the position and prospects of the Irtysh Corporation itself, but of the position and outlook for Russia. There are two questions I wish to ask the Chairman before I sit down. I will not detain you very long as we have already been here for some time. I am sure I am expressing the feelings of the meeting when I say that we heartily support the measures when the board have adopted in order to safeguard our interests. I am sure that one and all will agree with me in that statement. Now, Mr. Chairman, I wish to ask you two questions. My first question you may think somewhat foolish. It has reference to the conversion rights of the debentures. Considering the relatively high conversion price of the debentures and the present low price of the shares, I should like to know whether any of the debentures have been coverted during the past year? The other question I wish to ask you refers to certain properties you yourself—already to my own knowledge—have been developing in the Steppe district, and which you have told us in your address to-day you have handed over to the Russo-Canadian Corporation. Last year we heard of wonderful prospects in regard to the porphyry property. I think it is near the Ekibastous district. I want to know whether the porphyry property is one of those properties you have handed over, or whether that porphyry property is being retained solely for the benefit of the Irtysh. I will not detain you any longer, but I shall be much obliged if you will answer those questions.

The Chairman: I have to thank Mr. Moore, on behalf of the directors, for the kind manner in which he has appreciated the work we have done in reference to carrying through the Russo-Canadian Corporation deal. Naturally this has taken a great deal of time, anxious thought and consideration, and I think the directors do really deserve a word of thanks for what they have done in this matter. At the same time I think it would be unfair if we took all the credit to ourselves. We have had the advantage of co-operating with a gentleman known to many of you here—I refer to Mr. Edward Mackay Edgar. He is a gentleman who has had a very large experience in these matters, and his keen insight, intellect and unfailing courtesy during the period of all these negotiations and discussions have been of immense assistance to us and have greatly helped towards the success of the scheme. I should like you to add the name of Mr. Mackay Edgar to the vote of thanks which has been proposed by Mr. Moore.

With reference to the question of the exchange of debentures, I would mention that the British debenture holders have not thought well, with the exception of a very few, to exchange their debentures at the present time, when the shares are very much below their intrinsic value. The Russians, however, who perhaps are greater optimists than we are and happen to know their own country better than we do, and realize the possibilities of this property better than the general public in this country, have practically exchanged all their debentures. I think this is a remarkable proof, gentlemen, of the trust which the Russians show not only in the management of this company, but in the future of our properties. Debentures to the amount of £77,000 were presented for exchange a few days before the meeting by the principal bankers in Petrograd, who are interested in our companies—practically the whole of the debentures held by them.

I now come to the second question asked by Mr. Moore with regard to the porphyry properties at Ekibastous. The Elemes porphyry property is a few miles away from the coal mines and does not come into this deal. These properties belong in their entirety to the Kirgiz Company, the shares of which are owned by this company, and they will probably form a source of revenue to this company after the war. We hope to deal with that matter later on for the benefit of the shareholders.

The resolution was then put to the meeting and carried unanimously.

The Chairman: The next business of the meeting is the re-election of the retiring directors. I beg to move: —"That Messrs. D. P. Mitchell, T. Blair Reynolds and Mr. Herbert Gibson"—who, as you all know, is solicitor to the company—"be re-elected directors of this corporation."

Mr. C. J. Cater Scott seconded the resolution, which was unanimously agreed to.

Mr. F. M. Coldstream: I beg to propose:—"That Messrs. Deloitte, Plender, Griffiths and Co. be reappointed auditors to the corporation for the ensuing year at a fee of 40 guineas."

Captain M. A. Arbuthnot seconded the motion, which was passed unanimously.

Mr. Francis Moore: Just one word, gentlemen, before we separate. I should like to propose a hearty vote of thanks to our Chairman, to the directors and to all our Russian friends who have assisted us through these perilous times. I should like to add that our friend Mr. Hoover and Mr. Leslie Urquhart as long ago as September, 1914, commenced work in connection with the scheme which the Government is now putting forward in its Non-Ferrous Metals Bill. They themselves represented to the Government the serious position in which the spelter industry and the base metal industry in general was at that time, and they have been working on the scheme ever since. I myself introduced Mr. Hoover to the Government and it has taken three years for the Government to bring forward their proposals and to grasp the idea underlying the scheme of Mr. Hoover and Mr. Urquhart. We congratulate both Mr. Urquhart and Mr. Hoover on what they have accomplished in this direction. Mr. Hoover, as you all know, is now the Food Controller of the United States. Gentlemen, I propose that a very hearty vote of thanks be accorded to the Chairman and directors, and to all our Russian friends who have co-operated with them all through these perilous times in Russia.

The motion was carried by acclamation, and the proceedings then terminated.

TANGANYIKA CONCESSIONS, LIMITED.

Directors: Tyndale White (*Chairman*), Lord Arthur Butler, T. P. Heyvaert, Thomas Honey, G. C. Hutchinson, Sheffield Neave, C. F. Rowsell. *Managing Director:* Robert Williams. *Manager and Secretary:* L. Scotland. *Head Office:* Friars House, New Broad Street, London, E.C.2. *Formed* 1899. *Capital issued:* £980,098 in £1 shares; debentures £2,226,990.

Business: Holds 40% in Union Minière du Haut Katanga, the Belgian company working copper mines in Congo State; operates and controls the Rhodesia-Katanga and Benguella railways.

The ordinary general meeting was held on December 12, at River Plate House, 7, Finsbury Circus, London, E.C., Mr. Tyndale White (the Chairman) presiding.

Mr. L. Scotland (Manager and Secretary) read the notice convening the meeting and the report of the auditors.

The Chairman, in moving the adoption of the report and accounts, explained that the delay which had occurred in the holding of the meeting was due to the fact that the directors had had to wait until certain information had arrived from Africa.

Mr. C. F. Rowsell seconded the motion.

Mr. Robert Williams (Managing Director) then addressed the meeting. He said: Before telling of the progress made in our mineral and railway operations, I will briefly deal with the report and accounts, which I presume you will, as usual, take as read. The figures in the balance sheet do not show any great change from those of last year, and it will be quite unnecessary for me to refer in detail to the different items which are clearly set out and speak for themselves. There is no change in your issued capital, which remains the same as last year, viz.: 980,098 shares. The debit on the profit and loss account for the year, which is chiefly for interest on the debentures reserved, but not paid, amounts to £143,306. We have, as usual, been able to carry the debit balance to the premium on shares account. There is still a small balance remaining to the credit of that account, and unless something unforeseen happens, this is the last debit balance you will see on our balance sheet. Since the date of your balance sheet, I have been able to arrange for the necessary finance to enable us to repay some of the outstanding debenture interest coupons. Last year when we met we owed four coupons up to July, 1916, amounting to £237,922. Since that date we have paid three of these, amounting to £179,425, and a further coupon amounting to £58,496 will be paid on January 1 next. There will then be three coupons outstanding from January 1, 1917, to January 1, 1918. These will gradually be paid off in accordance with the promise made to our debenture holders to pay these coupons, although they had given us the right to withhold payment until six months after the war. In addition to these sums, we have paid during 1917 under our guarantee of Benguella Railway debenture interest about £88,500, as well as all other expenses of the company. We are now considering ways and means to pay off our debenture debit *principal* as well as interest. As you are aware, we have until six months after the war to repay this debt, but it may be advisable for many reasons not to wait until that time.

Turning to the credit side of your balance sheet you will see the shares and debentures in other companies are entered at £3,467,854, 19s. 1d., being cost or under. This item includes your holdings in the following companies: 2,700,000 shares of £1 in the Benguella Railway Company, 98,000 shares in the Union Miniere du Haut Katanga, and 557,264 shares in the Rhodesia-Katanga Junction Railway & Mineral Co. Ltd. In order that you may see what is the present value of these assets, I cannot do better than give you the figure at which they would stand at market price. I am informed that Union Miniere shares have recently been quoted at over 2,000 francs per share, but even at half that price, say £40 per share, it would make the value of your shareholdings in other companies over £7,000,000, leaving a margin of over £3,500,000 above the figure mentioned in the balance sheet. Of course, I am taking your railway shares at cost as there is no market quotation for these at present. Out of a capital of £3,000,000 in the Benguella Railway you own 90%, and of the issued capital of 781,487 shares in the Rhodesia-Katanga Junction Railway & Mineral Company you own 70%. I will deal further with those interests later on, and will not take up more time now in dealing with the figures in the accounts.

I will now give you the latest information regarding your mineral and railway interests. During the year under review, right up to the present date, we have had to contend with great difficulties in managing the Union Miniere company. The operations of that company have been delayed by inefficient railways (British and Belgian alike), shipping troubles, scarcity of white labour and medical staff, and a great shortage of native labour. Most of these difficulties, although not all, have been directly attributable to war conditions. It has been a most worrying and anxious time, and these difficulties are not likely to decrease as the war goes on. Still, as the result of continued effort on the part of all concerned, we have been able to show most satisfactory progress and the output of copper which I had expected to be about 30,000 tons for 1917, will not be far short of that estimate.

The seven-furnace plant programme is now practically completed, and the smelting capacity will be increased by about 1,000 tons monthly as soon as the Rhodesia and Katanga railways can deal with the extra traffic. I understand they will be in that position at an early date, as a large amount of rolling stock is now being delivered for both these railways. Our output has gone on increasing steadily year by year since we started smelting in 1911 and has mounted up from 997 tons in that year to something over 27,000 tons this year, and it ought to be, and probably will be 40,000 tons next year, when the Union Miniere company will be the largest copper producer in the world outside of America. We are now considering a further increase of our smelting plant, and Mr. Wheeler has almost completed the plans and specifications for a complete leaching installation which is designed to utilize some of the great water power of Katanga. He is now on his way from America to consult with us about that plant, our aim being to arrive at an annual output of 100,000 tons as soon as possible. There is an abundance of ore. It is all a matter of more and more plant to deal with it and steel rails for the branch lines necessary to connect up our copper quarries and some slight preparation to prepare these quarries.

The cost of our 1917 production to date at the works is £29. 10s. per ton as against £28. 6s. 6d. last year. The additional cost of putting our copper on the market averaged £15. 16s. per ton last year and is estimated to average £23. 17s. 6d. this year. The cost of this at the present moment is £26. 10s. The total cost of the 1917 output on the market is estimated to average £53. 7s. 6d. per ton as against £44. 2s. 6d. for the previous year, the increase being almost entirely made up by extra shipping and insurance charges. It is satisfactory that the cost on trucks at the works has only increased by £1. 3s. 6d. This has been due chiefly to our paying our men a bonus on results, and these costs would have been lower still had we had plenty of native labour, and less trouble in getting coke and copper transported over the railways. It is estimated that our 1917 production will realize £114. 15s. per ton, giving a profit of £61. 7s. 6d. per ton. The total gross profit for the year will be over £1,600,000, bringing the gross profits of the Union Miniere company up to about £3,600,000, from which considerable depreciation and other charges have to be deducted. I should also mention that over £1,000,000 has been spent by the company on development and plant since war broke out.

These results are from copper alone. In view of the high price of tin and the arrival of the railway within reasonable distance of our tin deposits, we have new started operations on these deposits, and it is likely we will show some profit from this source next year.

With regard to your railway interests, the Benguella Railway has made satisfactory progress, notwithstanding the fact that shipping to the port of Lobito has been, up till now, almost at a standstill on account of war conditions. The commercial traffic has increased from 27,763 tons in 1913 to 43,289 tons in 1916, and the passenger traffic from 63,333 in 1913 to 106,977 in 1916. It is significant that the largest increase in goods traffic has been in mealies, beans, corn, and flour, which has risen from 9,885 tons in 1915 to 14,162 tons in 1916. The agricultural prospects along the route of the railway are most excellent, and the Zambesi Exploring Company has started to develop these. The revenue of the railway has steadily risen from £90,587 in 1913 to £117,550 in 1916, when the surplus of receipts over expenditure amounted to £47,998. The receipts for the first half of 1917 were £69,334, and expenditure £39,287, the excess receipts over expenditure for the half-year being £30,000. These results, which are entirely from local traffic, have been earned over 320 miles of railway and they go far to show that the railway will pay the interest on the capital invested in it from local traffic alone, when completed to the Congo frontier.

An expert railway engineer sent out some years ago by a foreign bank to report on the future prospects of the Benguella Railway, gave it as his opinion that allowing for 40,000 tons annual traffic from Katanga and local traffic, the railway would give a surplus of £252,000. This surplus is likely to be far exceeded when the railway is connected to Katanga, as the copper traffic of that district is more likely to be something near 100,000 tons annually than 40,000 tons. It is regrettable that the construction of this line was stopped by the war, as if it had been carried to completion from both ends it would now have been connected to the Cape to Cairo Railway, and Lobito Bay would have been in touch with every port in South Africa right round to Beira, and given a sufficiency of rolling stock on the South Africa railway systems, shipping might have been saved the trouble of sailing over thousands of miles of dangerous seas, with great economy in shipping and English coal. With very little further trouble, even Egypt might have received its supplies through Lobito instead of through the dangerous Mediterranean. The saving of shipping, as we all know, is a matter of vital importance not only during the war but after it.

When I last addressed you, I mentioned how Germans had secured control of British companies by buying up the shares of these companies, and I am glad to see laws have now been passed to prevent this. I know from that and from certain interviews I have had with Government Departments, that our Government is now wide awake to British commercial interests and I take this opportunity to suggest that our Government should now seriously study the question of utilizing African railways to replace shipping. The freights and insurance on goods have now reached such a figure that the study of this question has become an economic one as well as a vital one from the point of view of saving our shipping. This is very clearly shown by the fact that the pre-war rate from Beira to Europe per ton for freight and insurance was £1. 12s. 6d. and is now £16. 19s., and that figure may easily go higher, and ships may even cease to visit those distant ports. It is not only during the war we will be short of shipping but after it.

With regard to the Rhodesia-Katanga Junction Railway, according to figures supplied by the Mashonaland Railway Company, the receipts and expenditure for this line for the year ended December 31, 1916, were £92,078 and £35,570 respectively, which shows a balance of receipts over expenditure of £56,508. It is gratifying to note the increase in the traffic over the previous year. For the nine months ended September 30 last the surplus receipts over expenditure amounted to £43,340. The traffic on this railway will go on increasing with the expansion of our mineral industry in Katanga, as there is enough copper there to supply all the railways with sufficient traffic. What this line might lose in copper traffic, it would gain in fuel and other traffic.

To sum up, the gross profits of the Union Miniere company have grown from £2,000,000 in 1916 to about £3,600,000 at the end of 1917. The Benguella Railway surplus revenue was £47,998 at the end of 1916 and £30,000 for the first half of 1917. The Rhodesia-Katanga Junction Railway surplus revenue was £56,508 for 1916 and for the nine months ending September 30, 1917, it was £43,840. This year, our company has not only paid all its current expenses and guarantees for Benguella Railway, but in addition we have paid off two years arrears of debenture interest.

These results are highly satisfactory, but while the profits of the Union Miniere company are undoubtedly large and the prospects of that company are very bright indeed, I did not want you to take any exaggerated view of them, as they are the outcome of nearly sixteen years' effort so far as this company is concerned, and the expenditure of many millions of money on development, machinery and railways so far as this company and the Belgians are concerned as principal partners in the Union Miniere company. The profits to date, large though they appear, will not represent more than a small interest on the capital outlay.

The motion to adopt the report and accounts was carried unanimously.

CAPE COPPER CO. LIMITED.

Directors: T. Blair Reynolds (*Chairman*), J. E. Champney, John Taylor, J. M. V. Money-Kent, Marcel Paisant, C. Cahen D'Anvers. *Secretary:* P. J. Franks. *Office:* 9, Queen Street Place, London, E.C.4. *Formed* 1863. *Capital:* £720,000 in ordinary shares of £2 each and £90,000 in preference shares of £2 each.

Business: Operates the Ookiep group of copper mines in Namaqualand; has recently developed the Rakha Hills mines in Chota Nagpur, India.

The thirtieth ordinary general meeting was held on December 12, at 9, Queen Street Place, London E.C., Mr. T. Blair Reynolds (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said that mining costs, with freight and insurance, were £151,425, against £104,745 in the previous year. The principal credit item, copper ores and metal, had increased considerably—from £263,723 to £317,142. This was accounted for partly by the increase in the average selling price of copper; also in part it was explained by the fact that the copper ores and metal in stock were reduced from £407,544, at which they stood last year, to £198,124. The gross profit was £147,841, against £131,248. After providing for income-tax and depreciation and allowing for dividend paid and the amount brought forward, there remained a divisible profit of £108,800, out of which a dividend of 3s. per share, less tax, had been declared on the ordinary shares, making 4s. for the year—the same rate as for the previous year—and on the preference shares a dividend of 1s. 9·6d. had been declared. Their superintendent at the Cape was now unable to give any figure of tonnage for reserves in the O'okiep mine. Although there was still an indeterminate quantity of ore remaining, there was no doubt that after over fifty years of continuous output they must look forward to diminishing returns from this mine. In the Nababeep mine a good deal of the development during the year was in ore below the average, so that the reserves, based on a 5% assay, showed a reduction from 120,000 tons to 90,000 tons. At the Indian mines no development of importance had been undertaken, but the stoping operations which had taken place disclosed the fact that the copper-bearing lode was of a greater width than was formerly assumed, and it was anticipated that the ore in the mine, though of lower average assay, had a considerably higher gross copper content than had been originally estimated. It was much to be regretted that the Rakha mines were still not revenue-producing. The blast-furnace plant was complete and had made a satisfactory trial run. For some time past it had been evident that, having regard to the extremely high freights and the constantly increasing costs of smelting at Swansea, there would be a loss on sending home the products of the blast-furnace. Further plant had been ordered, and was now being manufactured, which would ensure the production of copper saleable in India. They had at the Rakha mines ore-bodies of proved value with the promise of large extensions, and the work done there went to show that these mines would prove worthy to take the place of those which had made this company successful in the past.

Mr. John E. Champney seconded the resolution, which was carried unanimously.

LUIPAARD'S VLEI ESTATE & GOLD MINING CO., LTD.

Directors: Alexander Davidson (*Chairman*), W. Dereham, F. H. Hamilton, Sir Leigh Hoskyns, James Neill, E. Turk. *General Manager:* H. E. Allen. *Secretary:* William Smith. *Office:* 10 & 11, Austin Friars, London, E.C.2. *Formed* 1888. *Capital issued:* £472,012; debentures £63,990.

Business: Operates a gold mine in the far west Rand.

The twenty-second ordinary general meeting was held on December 12, at Winchester House, Old Broad Street, London, E.C., Mr. Alexander Davidson (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, said that the gold sales were £271,904, against £282,660 last year; the estate income and sundry revenue was £9,577, or £444 less than last year. Working expenses were £8,827 more. The ore reserves showed a slight reduction when compared with the estimate made a year ago, but in comparing the two figures the fact should be borne in mind that the working costs stood now at 20s. as against 19s. last year, and that for this reason a certain percentage of what was payable ore last year had automatically been removed into the category of unpayable ore. The management was meeting the exigencies of the situation by increasing as much as possible the percentage of rock sorted out before being sent to the mill. To a certain extent this was again a question of having sufficient native labour available. Since the close of the financial year the percentage of ore sorted out had risen from an average of 19·14% to 22·42% during September. Another good feature in the general development of the mine was the satisfactory results obtained from the Battery Reef, especially from the east section, and in a lesser degree from the west section. These two mines were quite separate from what might be called the old mines, Luipaards Vlei, or western section, and Windsor or eastern section. The Battery Reef was a separate occurrence which outcropped a good many hundred feet to the south of the outcrop of the main reef and south reef, and the value of its ore was nearly 20% higher than that of the Main Reef. Last year they took a little over 15% of their ore from the Battery Reef, but they were gradually trying to increase that percentage, and he had every confidence that they would get from the Battery Reef a considerable addition to their ore reserves and ore of higher grade for the mill. The relations between employers and employees on the Rand were showing steady improvement. A cable was published recently to the effect that representatives of the Chamber of Mines and the Mineworkers' Union had concluded an important agreement, which promised to remove in a large measure the causes of friction between the mine managements and employees.

Sir Leigh Hoskyns seconded the resolution, which was carried unanimously.

MOUNT YAGAHONG EXPLORATION & FINANCE CO., LTD.

Directors: Alan Cadell *(Chairman)*, Edward Bedford, A. T. Macer, W. Egerton Martin. *Secretary:* E. J. Townsend. *Office:* 52, Queen Victoria Street, London, E.C. *Formed* 1903. *Capital issued:* £22,427 in preference shares of £1 each, and £109,622 in ordinary shares of 2s. each.

Business: The finance of mining and other business; has a controlling interest in the Middleburg Steam Coal & Coke Co., and in several rubber and sugar companies operating in the Malay Peninsula and elsewhere.

The thirteenth ordinary general meeting was held on December 12, at the London Chamber of Commerce, Oxford Court, London, E.C., Mr. Alan Cadell, C.S.I., J.P. (Chairman of the company), presiding.

The Chairman, in moving the adoption of the report and accounts, said they had had a revenue from dividends, interest, etc., of £12,192, as compared with £10,338. last year. The figure would have been higher if the balance dividend on their large holding in Kinta Kellas had not been delayed, but it would, of course, come into the current year. They proposed to distribute a balance dividend of 4%, making 8% for the year ended June 30, 1917, and to carry forward £3,552. The revenue position was really much better than it looked on a first glance at the account, and the company during the year had made greater progress than in any other previous year of its existence, and there was every reason to feel confident of its future.

Mr. Edward Bedford seconded the motion.

Mr. A. T. Macer said that two years ago he was able to report that they had paid off their loan at the bank, that they had no liabilities, and that their assets were represented by values in the balance sheet. In these accounts they had divided their assets into groups—rubber, coal, and mining shares. The rubber asset stood at £69,879. At present values this would realize something over £150,000—something more than double the book value. That was the progress in two years in their rubber investments. Then in regard to coal, their colliery undertaking—leaving out of account Zondagsvlei—stood in the books at £38,000, and at present market values that came out at £50,000. The share interest and other things were at the low figure of £4,394. Roughly, their assets were sufficient to pay off the preference shares, and beyond that—some years ago they had to write off 8s. from the shares, reducing them to 2s.—to-day they had attained a position by which they had reached a long way to recouping the difference between 2s. and 10s. Roughly, their liquid assets, share assets, and the value of the uncapitalized assets were worth a quarter of a million of money as compared with an issued share capital of £132,047.

To come now to two new assets which had been described by certain shareholders as rotten eggs. He would say that an egg might be bad to eat, but it might be possible to sit on it long enough to produce a healthy chicken. In the Mutamba and the Transvaal Oil Shale they had two very healthy chickens indeed. The Transvaal Oil Shale two years ago did look a bit of a bad egg, but that company would have two good assets in the Station Colliery aud the Carolina Colliery. He anticipated that from July next the company would be earning £10,000 on a capital of £60,000 and debentures of £10,000. With regard to Mutamba, they went into it because it was in great need of assistance. Mutamba had been very badly managed and was short of money. They went into it and advanced certain moneys. They had a first security on the whole undertaking, and they were entitled to repayment of their cash with 7% interest, and in addition to that they were entitled to 25% of the profits of that company in perpetuity. In the last six months Mutamba had changed its management: it was quite time it did. Its old sugar areas were being replanted, and new areas were being planted, and arrangements were being made to put its really first-class plant into working order, so as to be able to deal with cane purchased from neighbouring farmers, which was a very lucrative form of business in Natal. They were told by the manager that two years hence the crop of sugar would be 2,000 tons.

They had in the Zondagsvlei acquired an entirely new asset. When this company turned the corner ten years ago it abandoned its Westralian assets and went into coal in the Transvaal. They had had a number of years' experience of coal working in the Transvaal. They acquired the Middelburg holding, and had not only the experience they had gained on this side, but they had had the advantage of an expert on the other side—Mr. Goodwin—and it was on his advice that they had acquired an option on something like 4,000 acres of coal-bearing land which was situated adjoining the Oogies mine of the Transvaal Coal Trust, on the main line of the railway from Witbank to Johannesburg, and 20 miles nearer to this big market than Middelburg. During 12 months Mr. Goodwin had been prospecting the area by drills, and they had found large seams of coal, and had proved the very great value of the property. The values were not quite so high as at Middelburg, where there were exceptional values, but they had a very big asset indeed there, which they did not propose to deal with until the cessation of the war enabled them to do so at normal cost. If they tried to do it now they would very probably have to pay double values. There was an asset there one-half of which would form an asset for the Middelburg, and would double its life as a coal-producing property, and they had in their half also the nucleus of another big colliery which he thought would be quite equal to the Middelburg and an estate of very great value. During the time between this and the time when they would require to equip that property they would go on accumulating liquid assets.

Last year he was very pleased to be able to tell them that they had not only paid off their loan at the bank, but that they had accumulated a certain proportion of liquid assets. This year, as the Chairman had told them, they had something like 20% or 25% of their assets liquid, and they had to regard that position in the light of what it was two years ago. From that point of view, and taken on the whole, he thought he might say that for its size the Mount Yagahong Company now was as healthy and as progressive as, and had greater prospects than, almost any exploration company of its size in the City of London. This was the result of some 15 years of hard work on the part of the present board. The shareholders were to be congratulated and the board was to be congratulated on the fact that they were able to tell them that they had progressed more during the past year than in any other year of the company's history.

The motion was then put to the meeting and carried unanimously.

THE MIDDLEBURG STEAM COAL & COKE CO., LTD.

Directors: Alan Cadell (*Chairman*), A. T. Macer (*Managing Director*), Edward Bedford, W. Egerton Martin. *General Manager:* E. M. Goodwin. *Secretary:* E. J. Townsend. *Office:* 52, Queen Victoria Street, London, E.C. *Formed* 1902. *Capital issued:* £64,899 in preference shares, and £99,888 ordinary shares, both of £1 each; debentures £13,835.

Business: Operates a coal mine in the Middelburg district of the Transvaal.

The twelfth ordinary general meeting was held on December 12, at the London Chamber of Commerce, Oxford Court, London, E.C., Mr. Alan Cadell, C.S.I. (Chairman of the company), presiding.

The Chairman, in moving the adoption of the report and accounts, said that the coal sales for the year were 309,555 tons, compared with 297,225 tons for last year, an increase of 12,331 tons, and the gross profit (less depreciation) was £22,306, compared with £17,033 last year. After paying debenture interest, income tax, South African taxes, and administrative costs, they had £17,161, which added to the £6,248 brought forward, left £23,409. They had taken £5,000 from this for reserve, as compared with £2,500 last year. The preference dividend had absorbed £3,244. The balance dividend for 1916 approved at the last meeting required £3,745. They had paid 1s. per share interim dividend on account of the current year, £4,994, and they proposed to pay now a further 1s. per share, which would leave £1,430 to carry forward to the current year.

Mr. A. T. Macer, in seconding the motion, said he would deal with some questions raised by shareholders who were not present One question asked was as to the present position of the Transvaal Coal Owners' Association. The Transvaal Coal Owners' Association was formed four years ago for a period of five years, which was due to expire on July 1 next. As the result of negotiations during the last few months the Association had been renewed for a further period of five years, running from July 1 next. The allocation of trade to this company under the old award of five years ago, which expired in July next, was 17,100 tons per month. That allocation was based on the trade of the Transvaal colonies at the date of the inception of the Association. The new allocation of trade, based approximately on the current year's trading of this company, was increased to 26,400 tons per month, and they might expect a trade during the five years of the new Association of something in excess of that figure. The old Association was formed with a number of low-price contracts running. These contracts would expire during the current year, and the Association would be free to enter into new contracts, and be free to raise prices if it thought fit. Personally he hoped it would not raise prices very greatly, as their policy had always been to advertise cheap coal in the Transvaal so as greatly to enlarge its sphere and the trade for Transvaal coal. Another question asked was in regard to the gold claims. They had written off a heavy sum this year with respect to these gold claims. That did not mean that during the year they had expended more money on these claims. As a matter of fact, when the war broke out they ceased working and financing these claims. But they still had these claims, and they were as valuable as ever they were. They had, however, entirely written off the cost, and they stood in their books at nothing. The assets they had left consisted of shares. They had a large block of preference shares in the Station Colliery, and they had a block of shares in the Mount Yagahong Company, and others, and these shares were worth more than they stood at to-day in the balance sheet. Their balance sheet now represented good assets from top to bottom.

They would notice that in the accounts they had an item this year "prospecting reserve." That prospecting reserve originated from a suggestion of the auditors. The auditors each year had pointed out that they had written nothing off for depreciation. That was not because the directors had not had fully in their minds the ultimate exhaustion of the coal areas. Shareholders would remember that eight years ago they took up another 650 acres of area, so that to-day actually their coal resources were in excess of what they were on the day when the company started; but having regard to the fact that with the conclusion of the war there was certain to be an enormous development of the coal trade, and that they might have to deal with an output of 50,000 tons a month in trade, they would naturally, as they worked out more coal, shorten the life of the colliery and they had in this prospecting reserve started a fund to prospect new areas, and so lengthen the life of the colliery. He was pleased to say that they had taken up an option on the Zondagsvlei. They had a half interest in that estate, which was situated adjoining the Oogies Colliery of the Transvaal Coal Trust, and was two miles from the main line from Whitbank to Springs. It was twenty miles nearer to Johannesburg and the big markets than he Middelburg Colliery. They had had that option running now for twelve months. They had prospected it by a number of bore-holes, and in each of these bore-holes they had encountered very valuable seams of coal. The average of the coal in these seams was something like 12 ft., and they were satisfied that they had now sufficient information at their disposal to acquire this property. It would not add very much to their balance sheet liabilities, and in acquiring this property they would at least double their coal reserves. In that respect they had done an extremely good stroke of business for the company. In dealing with coal samples from bore-holes, of course, one had no opportunity of picking the coal, and the average from these showed the coal to be rather lower than the coal being sent to market from Middelburg, but they would remember that Middelburg coal stood quite at the top of the list of Transvaal coals. It would be a matter of very good fortune if they ever secure a property of so high a value as the Middelburg. It did not, however, follow that the average value in this new property would not be considerably improved by picking. The Middelburg coal, when they started there, was put on the market rather crudely and wet, and the values then were lower than they were to-day. The coal to-day is carefully picked by machinery, and it comes on the market in perfect condition, and it stood, as he had said, at the top of the averages for South African coal. In acquiring this property they had, as he had said, doubled their coal reserves, and more than doubled the life of the colliery as it stood at the beginning of last year.—The resolution was carried unanimously.